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PRELIMINARY REPORT
ON THE
NATURAL HISTORY
OF THE
STATE OF VERMONT.

BY AUGUSTUS YOUNG,
STATE NATURALIST.

BURLINGTON:
CHAUNCEY GOODRICH.
1856.

IN SENATE, Oct. 23, 1856.

Referred to the Committee under the 4th Joint Rule.

IN SENATE, Oct. 23, 1856.

Reported. Ordered to lie—and that the Secretary procure one thousand copies to be printed for the use of the General Assembly.

REPORT.

To His Excellency,

RYLAND FLETCHER,

Governor of the State of Vermont :—

SIR: On the twenty-ninth day of February, 1856, I had the honor of receiving from His Excellency GOVERNOR ROYCE the appointment of State Naturalist, to supply, until the next session of the General Assembly, the office which was rendered vacant by the death* of Professor Zadock Thompson.

Conscious that my present position is more attributable to the generous hopes of your predecessor than to any merits of my own, I hesitated awhile, by reason of failing health, to assume upon myself its weighty cares. Having, however, for many years devoted a portion of my time, and all of my leisure hours, to the study of Natural History, and especially of my native State, and become somewhat familiar with the physical resources of Vermont, and feeling anxious that the work, in which Professor THOMPSON was engaged at the time of his death, should be prosecuted to its completion without interruption, I ventured, not however without some misgivings, to take upon myself the burden of its duties.

As soon, therefore, as circumstances and a proper regard for the feelings of the family of my deceased friend would justify my so doing, I commenced my official service, and in due time, made a careful examination of the progress which had been made by my predecessors towards a "thorough prosecution and completion of the Geological Survey."

The first object of my enquiry was to ascertain the requirements of the Statutes authorizing a Geological Survey of the State: and

* See Appendix No. I.

I found that to the history of the legislation of Vermont on this subject is attached no want of interest. The matter of a Geological Survey of Vermont was first brought to the consideration of the General Assembly during the administration of Gov. Jenison, in 1836, and in the following year (October session, 1837,) the subject was referred to the Committee on Education, in whose behalf the late Gov. Eaton submitted to the Senate a carefully prepared report,* accompanied by able and important documents. Although the subject was discussed at each succeeding session of the General Assembly, the first Act was not passed until October, A. D. 1844,† and the second act received the executive sanction in December, 1853‡—the one making provision for the Survey, and the other providing for its completion.

The duties devolving upon the State Geologist, by virtue of the Act of 1844, are clearly set forth in the third section of said Act, and are as follow: "It shall be the duty of the State Geologist, as soon as practicable, to commence and prosecute a thorough Geological Survey of the State, embracing therein a full and scientific examination and description of the rocks, soils, metals and minerals; make careful and complete assays and analyses of the same; and annually, on before the first day of October, to report to the Governor the progress of the work, the most efficient and economical manner of conducting it, and an estimate of the expense for the ensuing year."†

By virtue of this Act, Gov. Slade appointed, as State Geologist, Professor Charles B. Adams, at that time Professor of Chemistry and Natural History in Middlebury College, who entered upon his duties on the first day of March, 1845, and who made four annual reports upon the Survey indicating its advancement, which reports were duly submitted by the Governor to the General Assembly, and printed and distributed among the people. The Legislature having made no provision for embodying the facts which were gathered during the three years of the Survey in a systematic report, and having failed to make any appropriation for a continuance of the work, the Survey was suspended—the manuscripts, field-books and specimens being locked up in about fifty

* See Appendix No. 5.

† See Appendix No. 2.

‡ See Appendix No. 3.

boxes, and in that plight, remaining at Burlington and Montpelier.*

In 1848, the General Assembly passed a Joint Resolution providing for the preservation of the materials for completing the Geological Survey, as follows: "*Resolved by the Senate and House of Representatives*, That all collections of minerals, field-notes, and all preparations and materials amassed by the State Geologist for a final report upon the Geological Survey, be brought together by some suitable person to be appointed by the Governor, and be deposited in the State House, under the care of the State Librarian, that nothing may be lost, and that the State may have the benefit of these collections, whenever the State shall deem it expedient to "prosecute the Survey to completion."†

Governor Coolidge commissioned Professor Zadock Thompson to carry into effect the foregoing resolution, whose report, under date of October 11th, 1849, is respectfully referred to and made a part of this communication.*

A final Geological Report, embracing the entire results of his labors and those of his Assistants, was never made by Prof. Adams, and on the nineteenth day of January, 1853, he died on the Island of St. Thomas, West Indies, summoned hence in the prime of his life and usefulness.

In the month of October, following the decease of Prof. C. B. Adams, the General Assembly passed "An Act to provide for completing the Geological Survey of the State," in and by which Prof. Zadock Thompson was appointed State Naturalist, with the following duties: "to enter as soon as practicable upon a thorough prosecution and completion of the Geological Survey of the State, embracing therein a full and scientific examination and description of its rocks, soils, metals and minerals; make careful and complete assays and analyses of the same; and prepare the results of his labors for publication, under the three following titles, to wit:

First—Physical Geography, Scientific Geology, and Mineralogy.

Second, Economical Geology, embracing Botany and Agriculture.

*See Appendix No. 4.

† See Session Laws, 1848. p. 36, No. 53.

Third.—General Zoology of the State.*

It will be noticed, upon comparison, that so far as regards Physical Geography, Scientific and Economical Geology and the concomitant science of Mineralogy, the Statutes of 1844 and 1853 imposed similar duties upon the State Geologist and State Naturalist—to which there can be, probably, no well-planted objection except to that requirement by which he is expected to make “careful and complete analyses of soils” with a view to a special application of Geology to Agriculture. Upon the doubtful utility of this requirement, I propose to offer some remarks in their proper place.

By the act of 1853, Botany and the General Zoology of the State are added to the previous act of 1844, thereby obviously contemplating a complete Natural History of Vermont, in three parts or subdivisions—a design which, if Providence had permitted Prof. Thompson to carry out to completion, would have possibly surpassed any thing of the kind in any of our sister States. It was one of Professor Thompson’s most ardent earthly aspirations that he might be allowed to present to the world in an entire, well-planned and well-executed work, the Physical Geography, and Natural History of his native State; and from the liberal views which prompted the passage of the act of 1853 it is obvious that a like laudable feeling and ambition pervaded the General Assembly. But in the death of Professor Thompson such expectations have been disappointed; and we may be compelled to satisfy ourselves with or rather to submit to such a Geological Survey as has, in general, been satisfactory to different States in our Union, consisting of carefully prepared and arranged reports upon the Natural History of Vermont. It is no disparagement to any living Naturalist or Geologist to express a doubt whether for many years to come there will be found among us another gentleman so ardent in his feelings upon the subject, or so well fitted by life-long series of observations and scientific examinations, to execute on behalf of the State a task of such magnitude and importance as was the late and highly gifted State Naturalist, Professor Zadock Thompson.

We may, however, gather consolation in the fact that so far as

* See Appendix No. 3.

the Zoology and Botany of Vermont are concerned, we have the results of the unwearied explorations and observations of Prof. Thompson, embodied in his Natural History of Vermont which was published in October 1842, and, beside this, we have record of his more recent and mature labors embraced in an Appendix to his History of Vermont which was published by him in a small volume of sixty four pages, in April, 1853—five years after the Geological Survey, under Professor Charles B. Adams as chief and Messrs S. R. Hall of Craftsbury and Zadock Thompson of Burlington, as assistants, had been suspended.

It is reasonable to suppose that if Professor Thompson had been permitted to live and finish the work which the Legislature had commissioned him to perform, valuable additions would have been made to his botanical catalogue as printed in his History and Appendix, and undoubtedly many plants would have been discovered and zoological discoveries made to reward his patient and enterprising research. Such plants and animals—however small or insignificant—are by no means unworthy the study or beneath the notice of any scientific enquirer: but it may be seriously questioned whether, since Professor Thompson, upon whom especial reliance was placed and in whom the hopes of the State centred, is dead and no longer able to answer the expectations which a grateful people indulged, the General Assembly would authorize or justify the expense which is incident to the compilation and publication of those parts of the Natural History of the State which comprised the departments of Botany and Zoology—even upon a reasonable assurance that such a work would not be in any wise slighted in the hands of others than those for whom it was designed. Apart from this consideration I have thus far been unable to ascertain that subsequent to his appointment as State Naturalist in October 1853, he had been subjected to any considerable expense in preparing materials for the publication of the second and third volumes of the Natural History of the State, as contemplated by the Statute of 1853. His attention had been chiefly bestowed upon a preparation for publication of a volume relating to the Physical Geography, Scientific Geology and Mineralogy of Vermont.

It may be possible that the materials already collected and prepared by Professor Thompson would have been sufficient to en-

able him to compile the three volumes contemplated by the act of 1853 by the addition of such extracts from his published works as may have been appropriate; but it may admit of some doubt whether any other person would be justified in making use of the same printed matter for the same purpose. The fact has been communicated to me that a large edition of his Natural, Civil and Statistical History of Vermont yet remains unsold, and I am unwilling to believe that inasmuch as his literary and scientific works constituted the chief legacy to his wife and family, any one would suggest or recommend any measure tending to lessen the sale of his valuable books or infringe upon the copy-right in which his family must feel no slight interest. If however, the widow and heirs of the late State Naturalist can be induced to waive their right and interpose no objection to a judicious use of that part of Professor Thompson's history which relates to the Natural History of the State, then there would remain no obstacle or objection in the way of using *all* of the labors of the late State Naturalist in carrying out the plan contemplated by the act of 1853.

Under these circumstances and influenced by the considerations which I have briefly mentioned I have esteemed it to be my duty for the present and until these suggestions are communicated to the Legislature, to forbear any attempts to collect or arrange materials for the Botanical and Zoological compartments of the proposed work, and have confined my labors and restricted my enquiries to those matters which relate more particularly to the Geological department in connection with Mineralogy.

My predecessor, Professor Thompson, at the time of his death had for causes to which I shall hereafter particularly advert, made but slight progress in preparing his reports for publication. I find, however, among the great number of papers, and collection of matter from which the materials for his final reports were to be drawn, a programme of his contemplated work contained in three small pamphlets in manuscript* executed in his remarkably neat and methodical manner, purporting to present the title-pages and tables of contents of the three proposed volumes. Each volume was entitled "Natural History of Vermont"—the first being devoted to Geology; the second to Botany; and the third to Zoology.* The contents of the first volume were divided into four parts, viz :

* See Appendix No. 9.

Scenographic Geology—Scientific Geology—Mineralogy and Economical Geology—all constituting in my judgment, an excellent and most comprehensive programme: and, perhaps, no better and more methodical table of contents on the Geology of the State could be devised. The contents under the head or title of Scenographic Geology relate to the aspect of the country, Mountains, Hills, Watersheds, Valleys, Chasms, Caves, Springs, Streams, Ponds, Lakes, Swamps. On these subjects Professor Thompson has left a few pages in manuscript carefully enveloped as if prepared for the press: but aside from these papers I have been unable to discover many traces of his progress in writing out the proposed work for publication.

I have deemed it proper and incumbent upon me to allude to these facts in order to present a correct view of the present condition of the Geological Survey. Should it be thought advisable to postpone for the present further labors in the department of Botany and Zoology, it seems as if the materials already acquired together with such as may be obtained or prepared at a moderate expense might enable some competent Naturalist to arrange for publication such a final report of the Geological Survey as was originally contemplated by the act of 1844. The expense of such a report would be inconsiderable as compared with the benefits which would accrue, provided the analyses of the different soils of the State were dispensed with.

With regard to the chemical analyses of soils I would suggest that in order to have them of practical use or of scientific interest they should be made with extreme care and thoroughness and must, of necessity, involve greater expense than their very doubtful utility to the agricultural interest of the State would warrant.

The agricultural interest of a State is greatly paramount to any other and, in fact, to all other interests combined. "To subdue the earth," to make it perpetually fruitful is the province of agriculture and he must be a public benefactor who can discover some special means whereby the farmers of Vermont are enabled to increase their profits and diminish their labors, and he is doing the State some service who can induce the farming interest to adopt the best mode of preparing the soil and putting it to the most profitable use and to dispose of its products most advantageously to the soil and its owner: for thereby he advances the intelligence

and promotes the happiness of those who pursue a delightful but necessarily laborious calling. I owe it to candor to express my doubt whether any Geologist however skillful or Naturalist however learned or scientific, can, by traversing the State, collecting and arranging statistics of the average crops and calling the attention of farmers, to the well-known deposits of marl, muck, lime &c., in their respective vicinities, succeed in supplying the place of intelligent enquiry and careful observation in an enlightened farming community. There is no royal road to the successful pursuit of Agriculture any more than to any branch of domestic industry or department of science.

In regard to the chemical analysis of soils and some of the requisites of a valuable analysis I propose to offer a few remarks. A plant derives the principal part of its sustenance from the soil. The soil must contain certain fertilizing elements in due proportions to secure the perfect growth of the plant. If the soil be deficient in one or more of these essential elements, chemical analysis can detect the cause of the evil and point out the remedy "But," says Dr. John D. Easter, "the growth of plants is influenced by a multitude of other circumstances to which chemical analysis can furnish no clue, a soil may abound in all the elements of a very fertile one and yet be perfectly barren. The soil of the great Colorado desert in California, which I have recently analysed, furnishes a good example of this. It possesses in abundance every element necessary to extreme fertility, but is entirely barren from the want of water.

The reverse of this also frequently occurs. The chemist receives a specimen of the soil, in the chemical constitution of which he can detect no deficiency, and in his laboratory, he can assign no cause for its alleged unproductiveness. An examination of the locality probably shows him that it is underlaid by a stiff, tenacious sub-soil, which retains an excess of water, and no provision has been made for drainage.

The difference in the mechanical texture of stiff and loose soils is familiar to every one. The fertility of many stiff clays may be seriously impaired by ploughing too wet, rendering them tough and impenetrable to the tender rootlets of plants. In this case, as no chemical change takes place, the chemist in his laboratory would seek in vain for the cause of the difficulty.

Every attempt to improve the character of the soil must, therefore, be preceded by a judicious consideration of its mechanical texture, its power of absorbing and retaining water, and its capacity for heat. Hence it is important that the agricultural chemist should, if possible, himself examine the locality in order fully to estimate the wants of the soil. The employment by every State of an agricultural chemist, who should visit in person every part of the State, is therefore, strongly to be recommended.

In the next place it is requisite that an analysis of the soil, in order to be of much value should be thorough. It must include separate estimations of the parts soluble in water and in acids, and the insoluble portion. For the portion soluble in water represents what is available for the wants of the growing crop, while the portion soluble in dilute acids, is the index of what may by decomposition become the food of plants. This undecomposed portion of the soil may often, by the application of lime, ashes and other caustic manures, be more speedily decomposed and rendered available.

The analysis should include also, if possible, the sub-soil as well as the surface soil, in order to guide the farmer in the process of deepening his soil. There are, of late, many advocates of indiscriminate deep ploughing. But a fertile soil may be underlaid by a barren sub-soil, by throwing up large quantities of which the fertility of a field may be destroyed for years. The subsoil, not unfrequently, contains large quantities of protoxide of iron and other substances which are not injurious to vegetation until they have been subjected to the action of the atmosphere. On the other hand, the subsoil often contains elements of fertility which are not so abundant in the surface soil, in which case deep ploughing will improve both. It is important that the agriculturist should know these differences, in order that he may know where he should plough deep and where refrain.

A still more important consideration is, that no analysis can be of any value to the farmer who is not himself a chemist, unless it be accompanied by a discussion of the indications it affords, and a recommendation of suitable means of improvement. Our agricultural journals and reports abound in analyses which are about as intelligible to the unscientific farmer as the inscriptions on the pyramids, or a chapter from La Place's *Mechanique Celeste*. Most of our intelligent farmers know that lime, phosphoric acid,

and the alkalies, play important parts in the economy of vegetation, but few of them have any idea how much of these valuable ingredients is requisite to fertility, or what are the best means of supplying their deficiency. Until every farmer is also a chemist, an analysis of a soil or manure which is not followed by a commentary on its defects or virtues, leaves him just where the diagnosis of a disease, without a prescription for its relief, leaves the patient. He is no wiser nor better off than before. It will not do to presume that when the chemist pronounces what a soil contains, the agriculturist will know what it *ought* to contain, and how to supply its wants. Every farmer should insist upon an interpretation of the analysis furnished him by the chemist.”*

In regard to the benefits to be derived by the agricultural interest from chemical analyses of soils, I beg leave to quote from published letters written by President Hitchcock of Amherst College and by Prof. Benjamin Silliman, Jun. of Yale College, New Haven, Connecticut.

President Hitchcock in a letter† to our first State Geologist says : “I should not think it strange if some should be disappointed, as they have been in other States, by anticipating too much from the mere analyses of soils. The impression is very strong through the community that the chemist, by such an analysis, can determine what is wanting to render a soil fertile or what renders it barren. Now even admitting that he could do this, an analysis of the soil from almost every farm in the State, nay, from almost every field, would be necessary to make it of much value; and it is not generally known that every such analysis, accurate enough for this purpose, could not consume less than two or three weeks. But I do not believe that agricultural chemistry is yet far advanced enough to enable the chemist to say in many cases what ingredient added will be sure to render a barren soil prolific; although it is more easy to detect hurtful ingredients. But the analysis of some of the prevailing soils of the State (for example those from the limestone, mica slate, gneiss and and argillaceous slate regions,) will enable you to make suggestions that may be of great use.”

Professor Silliman, Jr., in his correspondence‡ with Professor

*See Appendix No 10.

†See First annual Report on the Geology of the State of Vermont by Prof. Adams, pp. 67, 68.

‡See Prof. Adams' Second Annual Report on the Geology of Vermont, pp. 262, 263.

Adams, makes the following expressive remarks: "I hardly know what answer to make to your enquiry about the terms for analyzing one hundred specimens of soils, &c. Our customary charge in analysis has been five dollars for every determination. This makes a round bill, but not more than a fair quid pro quo for the labor and skill required. It is the rate affixed by the joint agreement of several chemists. However we always make an abatement from it in case of many analyses of the same sort. No doubt, *a sort of analysis* of a soil may be made for five dollars, all told, but what sort I will not say. In my opinion the present state of science demands that an analysis of a soil, to be of any use whatever, must be minute, and ought to comprise at least ten separate determinations, besides the *ultimate* analysis of the whole mass, by alkaline fusion, which is useful as showing the extreme resource of the soil. We now think that we must have—*First*, an analysis of the matter soluble from the soil by water alone; *Second*, the amount of the matters soluble in dilute hydrochloric acid; *Third*, the ultimate analysis by fusion, as just suggested; *Lastly*, we ought to know the *mechanical* condition of the soil, technically called its *mechanical analysis*, which requires a series of siftings, washings and weighings, distinct from all the preceding. Going through all these numerous but essential steps on sixteen soils for * * * * we made him a bill of five hundred dollars. The difference between fertility and barrenness is comprised within such narrow limits that only a minute analysis of the sort I have sketched, can be of much use. Agriculture gains nothing from any further multiplication of such analyses as the bulk of those which in past years have filled Geological and Agricultural Reports. We have enough such already. Unless an analysis of a soil can do something more than people have hitherto been content with, the result will soon be that agriculturists will, with reason, question the utility of chemical analyses as of any practical benefit."

If therefore, the foregoing quotations from the pens of the most accomplished geologists in the Union are to be treated as authoritative in the premises, any attempt to analyze the almost infinite variety of soils in Vermont with a view to subserve the agricultural interests of the State would involve an expenditure which by reason of any accruing benefit could not perhaps well be justified. Thus the agricultural chemistry of the state is properly and chiefly

referred to the observation and experience of its intelligent citizens and farmers who by no means treat the science of agriculture with disrespect and do not reject what is called *book-knowledge* on the subject as contained in the numerous periodicals and other works devoted to agriculture which are so generally circulated in their midst.

It is not for a moment to be presumed that the intelligent farmers of Vermont are wholly ignorant of the difference in the nature and fertilizing qualities of the soils pervading more extended tracts or ranges of the State and which have been chiefly produced by the disintegration of the different kinds of rocks which underlie or are in the vicinity of the soils which have been formed from simple minerals composing the rocks and consequently partake more or less of their mineral and chemical characters.

A general acquaintance with the different simple minerals and their characters of which these extensive ranges of rock are composed (and no new chemical analysis is required for this purpose,) enables us to get a general but imperfect understanding of the chemical composition of the soils which overlie or accompany them. It may here be remarked that those ranges of rocks and their accompanying soils run nearly North and South, and hence their difference becomes very apparent in travelling East or West across the State. This general difference in the chemical constituents of the several ranges of soil is doubtless all that was intended to be conveyed by President Hitchcock when he says that suggestions in regard to the "prevailing soils of the State (for example those from the limestone, mica slate, gneiss and argillaceous slate regions,) may be of great value." *

Aside from the considerations which these quotations embody and enforce, it is proper to add that the commonly received opinion that the soils of a country have originated from the rocks immediately under them is somewhat erroneous. All soils are derived from rocks broken or pulverized and so disseminated that the ruins of one rock may be supposed to be mixed with the ruins of a great many others. Every soil, therefore, may be regarded as a mixture of many soils and may be supposed to have come from many and often from wide spread localities. "If every par-

* See Prof. Adams' "First Annual Report on the Geology of Vermont," p. 68.

ticle in a cubic foot of earth were to be endowed with instinct and were to rise up and take its departure for its original rocky home, I have no doubt," says Professor J. A. Nash, "there would be a wide scattering, and I believe an extent of travel would be shown quite surprising to those who have not reflected on the subject."

It must be conceded therefore, that soils do not always depend for their composition or capabilities upon the rocks immediately underlaying them. Soils usually come from wide-spread regions generally North and North-west of their present location. Vermont soils however partake more of the character of the adjacent rocks than the soil of any other section of the Union. Under these circumstances to which I have alluded in very brief and, I fear, unsatisfactory terms, I venture to suggest that the further chemical analyses of soils ought to be postponed until they can be made upon a more extensive scale than is contemplated by the existing law. The time has scarcely yet arrived when the State of Vermont can employ an agricultural chemist to visit in person every part of the State with the view of examining the different soils and their physical or mechanical condition or their climatic location and thus be enabled to make a practical and scientific report upon the chemical composition and fertilizing elements of such soils as may be subjected to such analysis and examination.

But with respect to both the qualitative and quantitative analysis of the rocks and minerals of the State, there are abundant and controlling reasons why this requirement of the Statute should be faithfully observed by the State Naturalist. The mineral wealth of Vermont yet remains undeveloped. To the examination, description and arrangement of mineral substances already known or partially so; to determining the character of certain rocks and minerals so as to indicate their economical uses and to prevent useless experiments and wasteful expenditures of time and money, have the labors of my predecessor been to a great degree devoted. Circumstances to which allusion has already been made have conspired to prevent the results of those researches from being hitherto systematically arranged and presented to the public in such a manner as to be of the greatest practical benefit and most scientific interest.

There is such a diversity of soils in Vermont as to render the

Green Mountain State one of peculiar interest. The Western or Prairie States have soils so similar in many respects throughout their geographical limits, that an analysis of one part may be of service in determining the chemical composition of another, whereas the minerals of Vermont are as various as its surface soils, and its surface soils are so diversified as to have challenged the attention of admirers of the beautiful and picturesque as well as of scientific observers for many years. The extensive and inexhaustible quarries of limestone and marble, serviceable both as objects of architectural beauty and agricultural utility; the beds of serpentine or verd antique which so extensively abound in Roxbury, Cavendish, Ludlow, Lowell, Westfield, Troy and elsewhere;—the vast hills of granite lying in the eastern part of Vermont, ranging from the Provincial line of the boundary of Massachusetts, which have been so advantageously quarried for building purposes and of whose beauty and utility the State House at Montpelier is the most imposing exponent; the large slate quarries which have been wrought so extensively and contributed so much to the wealth of Vermont because of their peculiar excellence and which appear to be in no wise inferior to the best slates of Wales; the iron ores of various kinds which seem to be inexhaustible and extend from the northern to the southern limits of the State and are found principally on the western side of the Green Mountain range; the large beds of manganese lying in Bennington, Rutland and Addison Counties and to a greater or less extent in other localities extending to the Province of Canada and which are of such utility in the manufacture of chloride of lime, useful in bleaching processes; the beds of sulphuret of iron or copperas ore which are situated in Strafford, Corinth, Shrewsbury and other places and which under congressional protection have banished foreign copperas from American markets; the large beds of steatite or soapstone which have been advantageously wrought in Grafton, Bridgewater, Bethel, Cavendish, Moretown, Waterville, and other parts of Eastern Vermont; the beds of porcelain clay in Monkton and other localities together with fire-clay of which the best fire-bricks for furnaces are made; the beds of copper, lead ore and other metals—all these and others which I have not mentioned, render Vermont a most interesting field of enquiry for the scientific and economical Naturalist.

Many of the ores, metals and other minerals enumerated in this report have been carefully "assayed" or resolved into their constituent parts, and the results of such analysis carefully noted and preserved. It may be necessary, however, in view of their vast importance and utility to supply such deficiencies as may be found to exist, that the chemical analysis of each valuable metal or mineral may be presented, in a properly arranged descriptive table made convenient for the use and reference of those interested in such important items of intelligence.

While, for reasons heretofore given, the analyses of soils may not be practicable, and are of very doubtful general utility, there can be no limit to the importance of an analysis of the ores, metals and other minerals which constitute so great an element in the wealth of the State. In fact its utility can hardly be exaggerated.

While impressed with the importance of a complete development of all departments of the Natural History of the State which savor of practical utility, and aware of and duly appreciating the natural and laudable wants and wishes of the people of Vermont in this particular, I am by no means insensible to the manifold attractions which our State presents to the scientific or theoretical enquirer. While the geological surveys of New Hampshire by Professor Charles T. Jackson, of Massachusetts by President Edward Hitchcock, of New York by William W. Mather, Dr. Ebenezer Emmons, Prof. Gardner Vanuxem and Prof. James Hall, and of the Province of Canada by Sir William Edmond Logan, have greatly tended to develop their mineral and natural resources, it cannot be expected that Vermont will be backward in ascertaining the extent and variety of her internal resources. The enlightened policy which gave origin to the existing law providing for a completion of the Geological Survey will undoubtedly bear the Survey onward to its proper consummation. Although the science of Geology is yet in its infancy, and the theories of to-day may give place to the more plausible theories of to-morrow, yet whatever of permanent scientific interest attaches to the Geological Survey of Vermont ought to be recorded and presented to the world so soon as the Survey is completed and the entire field has been thoroughly explored.

The objects of scientific interest in the Natural History of Ver-

mont are so numerous as to have attracted the attention of the best naturalists of the world. There can be no doubt but the thorough completion of the Geological Survey will bring to light many valuable discoveries—valuable in the two-fold view of economy and science. “Vermont,” says President Hitchcock, “is considered as the disputed ground in respect to certain problems of sublime interest.” The rock formations in Vermont are exceedingly complicated both in respect to their mineral composition and to their geological order and age. While the greater part of the rocks exhibit plains of sedimentary deposit and thus give proof of an aqueous origin, they are also very crystalline in their structure and indicate that during some period of their history they have been subjected to a very powerful metamorphic agency. The series of rocks which are presented to the eye are involved in so great obscurity in regard to their geological periods or epochs as to have puzzled geologists for many years.* Taking into view the adjacent parts of New York and New Hampshire, we have three ranges of mountains nearly parallel: the Adirondac on the West, the White Mountains on the East and the Green Mountains lying between them separated from the former by the valley of Lake Champlain, and from the latter by the valley of the Connecticut river. The Adirondac and the White Mountains differ entirely in their character from the Green Mountains, for while the two former consist principally of granite and other igneous rocks, the latter, with the exception of a few trap dykes and a range of serpentine, is composed of highly metamorphic and crystalline shales.

Aside from the peculiarity of the rock formations, the Geology of our State is interesting by reason of the numerous deposits of marine shells of the pleistocene period—some of which according to the late State Naturalist, are more than two miles inland from Lake Champlain, and, at least, two hundred feet above its level.

The interest attached to the Geological Survey of a State so rich in natural and mineral curiosities as Vermont, will increase as the Survey advances. As the useful minerals continue to be more generally understood and more freely developed, and while the means of prosperous enterprise are continued to her citi-

*See Appendix, No 6 and 7.

zens, we are enabled to have some glimpses of the relative age and connection of the rocks of the State as well as of some of the causes which have so modified and diversified the coast of this portion of our earth. So, too, we have a fair promise of being able to trace the connection of the rocks of Vermont with those of Canada, and of other States, as well as of other parts of the globe.

Moreover the discovery of rare organic remains by my predecessor has awakened considerable interest among paleontologists, and the paramount authority of fossils in ascertaining the relative ages of strata is maintained with additional force. I need not say that the moral influence of such discoveries, and in fact of the study of Natural History generally, must be healthful and elevating, for such discoveries "constitute the links in the mighty chain of causes and effects to connect created with uncreated mind."

It is a source of painful regret that the career of Professors Thompson and Adams closed before the work assigned to them by the Legislature had been fully performed. It was the dying lamentation of Professor Thompson, who loved his native State and her people and devoted his life to an enquiry into her Civil and Natural History, that Providence could not permit him to finish the work for which he was appointed. It is due to his memory to state, that apart from the inroads upon his time and opportunities for research which disease had made during the latter part of his life, he met with obstacles in the way of completing the Geological Survey which were almost insurmountable. One and the chief of these he has alluded to in the following terms which I find among the various manuscripts which he left, and which by virtue of my appointment have been entrusted to my examination and custody.

"In the first place I have been very much disappointed in relation to the *field-notes* of our former State Geologist, the late Prof. C. B. Adams. I was aware during the progress of his labors, that he kept many of his notes in a short hand of his own contriving, and remonstrated with him for so doing. Still I hoped to make out enough from them, to save the trouble of going over any considerable portion of the ground again. But in this I have been greatly disappointed. His notes I find to be exceedingly

brief and so obscurely expressed in a system of contractions to which he has left no key, that I find it nearly impossible to derive any information from them. After spending much time over these notes to very little purpose, I applied to Prof. Adams' widow, thinking it possible that she might be so well acquainted with his method of taking notes as to be able to decipher them; but she declined undertaking it, thinking it doubtful about being able to make out anything from them which would be of service to me.'

With regard to the collection of "minerals, field-notes, maps and all preparations amassed by the first State Geologist for a final report upon the Geological Survey," I would here state that they were duly deposited in the State House in the care of the State Librarian, and subsequently taken into the custody of the late State Naturalist. The specimens which were in a proper condition for a State Cabinet were suffered to remain at Montpelier, and the other specimens which have been since partially examined, trimmed and catalogued, I have ordered to be transported to Montpelier. Those specimens which were in a proper condition have been temporarily arranged in the room set apart for that purpose, and the residue are collected in room No. 37 of the State House, to be distributed at an early day to the literary and medical institutions of the State which are entitled to the same, and the balance to be in readiness for future foreign exchanges when deemed desirable. Although at present not in such order and perfection as might be wished, yet they indicate the abundance and variety of the mineral wealth of Vermont, and suggest the benefits which will undoubtedly flow from its thorough development.

In regard to the size of the specimens for the several collections, the rule adopted at the outset of the Geological Survey prescribed that, when the materials admitted, the specimens were to be three inches square and not less than one inch in thickness. Eight suites of these minerals duly trimmed, numbered and named were to be preserved, whose destination was to be as follows: One (and the best one when there was a choice,) for a State Collection at Montpelier; one for the University of Vermont; one for Middlebury College; one for Norwich University; one for each of the Medical Colleges at Castleton and Woodstock; one for the Troy Conference Academy at Poultney and one to be the property of the State Geologist.

With some exceptions, the specimens of more than two thou-

sand in each suite have been duly delivered to such of the aforementioned institutions as were willing to pay the expenses of transportation from the geological depots at Middlebury and Burlington. A few fossils and specimens which have been recently trimmed and ticketed, have not yet been forwarded to their final destination.

Rare and valuable specimens are placed where the State Naturalist can have ready access to them while preparing for publication his final Report on the Natural History of the State. The number of specimens of rocks, fossils and minerals, which are to undergo a "full and scientific examination" is very great, and of these many minerals and metals are to be "described" in a full and scientific manner, to meet the requirements of the Statute of 1853. Apart from this laborious duty, careful and complete assays and analyses are to be made, by means of which a determination of the value of different ores and minerals can be secured; and when these duties of examination, description and analysis are performed, the results of the State Naturalist's labors are to be systematized and prepared for publication in the mode prescribed by the Statute.

In the progress of the Geological Survey under Prof. Adams, he was assisted in the field labor by the Rev. Zadock Thompson, and the Rev. S. R. Hall of Craftsbury; and the chemical analyses were performed in the well furnished laboratory of Yale College, by Denison Olmsted, Jun., of New Haven, Conn., who was commissioned as Assistant Geologist, and served in that capacity until his death, August 15th, 1846. The report of Mr. Olmsted, forms a part of Prof. Adams' Second Annual Report, and is a valuable portion of the Appendix. Subsequently to Mr. Olmsted's death, Mr. Thomas S. Hunt, now of Montreal, was appointed Assistant State Geologist, in order that his valuable services might be secured in the Mineralogical department of the Survey, and his reports of the chemical analyses made by him were communicated to Professor Adams and appended to his reports on the Geological Survey, before Mr. Hunt accepted the position which he now holds of Chemist and Mineralogist to the Geological Survey of Canada.

Other experienced gentlemen were engaged in field labor and as assistants. Dr. S. P. Lathrop, Messrs. L. F. Locke and Edward

Hitchcock, Jun., are favorably noticed in Prof. Adams' Reports, and to Prof. Louis Agassiz of Cambridge ; Prof. James Hall and Dr. Ebenezer Emmons of Albany, N. Y ; Dr. Asa Fitch of Salem, N. Y ; Prof. Benjamin Silliman, Jun., of New Haven, Conn., Dr. Samuel W. Thayer, now of Burlington, Vt., Dr. James Robbins of Chester, Vt., and others, was Prof. Adams greatly indebted for advice, assistance and friendly co-operation in his professional and responsible labors. If Prof. Adams had completed his original design of preparing a final Geological Report, the value of the services and aid of these learned gentlemen might have been incalculable.

I am not aware that my predecessor Professor Thompson was regularly aided in his arduous task by an assistant Naturalist. He was, however, in constant correspondence with prominent Naturalists in this country and abroad, and in intimate relations with his friend and medical adviser, Samuel W. Thayer, M. D., who has taken great interest in all matters connected with the Geological Survey of Vermont from its start, and also with Professor James Hall, of Albany, N. Y., who rendered aid near the close of Professor Thompson's life in cataloguing valuable fossils, and in making scientific examination of rare trilobites which Professor Thompson had obtained in his researches throughout the State. Professor Henry Erni, then a Professor of Chemistry, Pharmacy and Toxicology in the Medical Department of the University of Vermont, made on his behalf some chemical analyses which are preserved in part among the manuscripts which were left incomplete by Professor Thompson at the time of his death. I greatly fear that a large portion of the labors of these assistants and correspondents cannot now be made available to the world by reason of lapse of time and other untoward causes. Undoubtedly the vast array of notes and memoranda belonging to the Survey would have been of inestimable value if they had been prepared and kept in a more methodical and intelligible manner, and the difficulty of compiling final reports would have been materially lessened and their value greatly enhanced.

At the last session of the General Assembly I find that the following resolution was adopted:*

"Resolved by the Senate and House of Representatives, That

*See Appendix, No. S.

the Sergeant-at-Arms be and is hereby directed to set apart and prepare the committee room, numbered fourteen, for the use of the State Naturalist for the deposit and arrangement of the specimens collected and to be collected in the Geological, Botanical and Zoological Survey of the State." *

This resolution which was so opportunely offered and adopted is prospective in its character and evidently contemplates the formation of a State Cabinet of the Natural History of Vermont—a purpose which will meet with the approval of every thoughtful citizen. This important step has undoubtedly been taken towards the formation of such a Cabinet for the purpose of collecting and preserving to all time, valuable specimens of the Natural History of the State, and affording a safe and attractive repository for the discoveries resulting from the future researches of inquisitive and scientific inquirers. The minerals and other geological specimens already collected in great numbers by the State Geologist and State Naturalist will form the basis of the State Cabinet as this Resolution implies, to which great additions can hereafter be made in the botanical and zoological departments of Natural History.

The State House seems to be the most central and, therefore, the most appropriate locality for such a Cabinet. Visited as the capitol is and always will be at all times of the year, every rare object in such a Cabinet would be universally seen and duly appreciated. Those persons who are making new discoveries in the mineral wealth of Vermont, and are desirous of exhibiting new and beautiful specimens of marble, serpentine, steatite, &c., to the largest number and in the most imposing and attractive manner would naturally contribute to it. Such contributions, originating as they might, possibly, in a wish to advertise the rare products of a particular locality will, of course, greatly tend to increase the beauty and add to the value of the State Cabinet.

Such a collection as this resolution implies will also facilitate the too much neglected study of our Geology and Natural History. If the rocks of Vermont are arranged in such a collection according to their respective counties and the organic remains

*See Appendix No. 8.

there exhibited, reveal the connection or prove the separation of certain strata and groups of rocks, the student of nature after examining them in the State Cabinet can at once repair to the localities where the rocks abound and thus familiarize himself in a short time with the Geology of the State. The wide range of animal and vegetable life* which belongs to Vermont will also present a wide field for scientific examination and the State Cabinet ought in time to possess specimens of all animals and vegetables which have lived or grown in Vermont, and each specimen presented or collected should be carefully preserved and named and the locality of each properly noted and all specimens calculated to illustrate the Ornithology, Erpetology, Icthyology and Entomology of the State should have a "local habitation and a name," in such a State Cabinet as the resolution contemplates.

Since the adoption of this resolution, the Sergeant-at-arms has prepared the room assigned to the department of Natural History, under the advice of the late State Naturalist with the view to exhibit until a more spacious room is procured, such specimens as are in readiness for the State Cabinet.

The minerals and other objects collected by the State Geologist and State Naturalist which have been too long locked up and thereby rendered comparatively useless for any practical purpose will upon being properly prepared, labelled and arranged be greatly enhanced in value. The duty of such a preparation and arrangement has been intrusted to my assistant Albert D Hager, Esq., of Proctorsville, Vermont, whose experience and skill fit him for the thorough and acceptable execution of this important trust and I respectfully submit to your perusal Mr. Hager's Report which is appended to this communication and bespeak for the suggestions contained therein a thoughtful consideration.

I take also this opportunity to express my grateful acknowledgment to my friend George F. Houghton, Esq., of St. Albans, Vermont, to whom I have issued a commission as Assistant State Naturalist and who has rendered me important service in the course of my labors as State Naturalist.

I have thus presented to your Excellency, in as brief a manner as the number and nature of the topics alluded to in this communication would permit, the several facts which tend to indicate the present condition of the Geological Survey. Although the Stat-

ute of 1853 requires no report to be made until "sufficient facts and materials shall have been collected upon the subject of Physical Geography, Scientific Geology and Mineralogy of the State to form a volume of not less than five hundred pages octavo," yet the peculiar circumstances I have referred to and the natural and laudable curiosity of the people of the State in regard to a matter in which they have manifested great interest from the outset of the Geological Survey, seemed to require of me a plain and unvarnished statement of such facts and explanations as would satisfy all reasonable enquiries.

In drawing this communication to an abrupt close I would, with due diffidence, express a hope that this statement and the appendix thereto may be laid before the General Assembly at your early convenience if your Excellency deem it proper, with such accompanying executive remarks as may secure to it a patient perusal and a candid consideration.

I have the honor to remain

Your Excellency's obedient servant,

AUGUSTUS YOUNG, *State Naturalist*.

ST. ALBANS VERMONT, October 10th, 1856.

REPORT OF ALBERT D. HAGER,
ASSISTANT STATE NATURALIST.

HON. AUGUSTUS YOUNG.

State Naturalist :

DEAR SIR :—In compliance with the instructions embraced in the commission of Assistant State Naturalist which you were kind enough to issue to me, I lost no time in proceeding to the Geological depot at Burlington. This depot, as you are aware, was a small building near the dwelling house of the late State Naturalist which had been used for a number of years by Professors Adams and Thompson during the continuance of their geological labors. I found that several boxes had been duly packed with minerals, and were in readiness to be forwarded to their final destination. Much the larger proportion of specimens, however, were in trays and required to be carefully assorted preparatory to being packed and boxed up. Inasmuch as the value of mineralogical cabinets greatly depends upon the character of the specimens, and a correct statement of their locality and properties, I aimed to pack each mineral and fossil with great care, wrapping with each specimen in all cases the appropriate label indicating its name and locality and in every instance of doubt had reference to the Catalogues which you entrusted to me for my examination and guidance.

You are aware that the specimens had been twice partly arranged by the late State Geologist and late State Naturalist; and the disadvantages under which I labored were increased by the system of short hand which Professor Adams used in his memorandum books.

This short hand and initials, written for the most part in pencil were in many cases perplexing and unintelligible. But in every instance where reliable information of the locality of all specimens could not be had, they were placed among those where local-

ity was uncertain or unknown—*certainty* being an indispensable desideratum in the formation of a cabinet of minerals.

In the instructions given by His Excellency Governor Slade to the first State Geologist, he was directed “to procure one suite of specimens for a State collection, and one for each of the three literary, and two medical colleges, and one for the Troy Conference Academy at Poultney.* Some of these institutions have not sent for their quota, and, unfortunately the number received by each institution was not minuted down in the books connected with the Geological Survey in such a manner (if at all) as to be a guide to any one but those who forwarded them. Probably the late Professors Adams and Thompson would have had no difficulty in discharging this part of their duty—while others might be greatly embarrassed who have no access to their private correspondence or key to their memoranda.

But I have endeavored to assign to each institution its quota of minerals as set apart and numbered by Professor Thompson—packing the contents of each tray and box and noting them carefully in my book of memoranda; and agreeably to your order, have forwarded them to Montpelier, so that the entire collection of minerals obtained by Professors Adams and Thompson is now at the Capitol either in number fourteen or number thirty-seven of the State House except what have already been forwarded to their final destination. The number already collected for the suites as contemplated by Governor Slade amounts to about twenty-seven hundred specimens for the State Cabinet, and a like number for each of the aforementioned literary institutions and medical colleges of Vermont, or about twenty thousand specimens, including a large number of surplus specimens which may be useful for future exchanges.

It will be my aim to collect, pack and get in readiness all of the minerals and fossils assigned for each institution, so that each college and literary institution can procure its quota upon application at the State House, during the session of the Legislature, and if I am present at the Capitol I shall take pleasure in facilitating their delivery.

With respect to other kinds of property belonging to the State which was stored in the geological depot at Burlington, I took

*See Professor Adams First Annual Report, page 7.

them into my custody under your directions and forwarded them to Montpelier. They consist of the following articles: sixty-three boxes for holding and packing minerals, one hundred trays for holding and assorting minerals, one table, one anvil and block, five maps, fifty sections of maps, two chairs, two sledges, six hammers, one drill, one iron bar, one box chisel, one tape measure, and a valuable barometer. Sixty-two boxes and seventeen trays filled with minerals and fossils, were forwarded from Burlington and delivered at the State House.

In pursuance of the Joint Resolution of the Legislature passed in 1855, the Sergeant-at-Arms has fitted up room numbered fourteen in the State House, under the advice and suggestions received from Prof. Thompson in his lifetime. This room is assigned for the "use of the State Naturalist, and for the deposit and arrangement of the specimens collected and to be collected in the geological, botanical and zoological survey of the State."

In the arrangement of the cases as made by order of the late State Naturalist, it is apparent that they were intended for the reception of specimens of the birds, fishes, reptiles, insects and other objects calculated to illustrate the Natural History of Vermont, as well as for the reception of Vermont minerals and fossils.

I have accordingly arranged the geological specimens in the division originally designed for their reception—thinking it highly probable that the State of Vermont might at no distant day procure if possible the very valuable private collection of the products of the State, which Prof. Zadock Thompson had taken pains to collect during the last thirty years of his life, and which collection is now in the possession of Mrs. Thompson, his widow, at Burlington. This being exclusively a *Vermont* collection, and embracing objects in all departments of Natural History, ought to be preserved entire, and it has occurred to me that the most appropriate place for its exhibition and preservation would be at the State House.

In room numbered thirty-seven I found about twenty-five hundred geological and mineralogical specimens trimmed and numbered—a due proportion of which I have removed to room numbered fourteen and arranged in the case prepared under the direction of Prof. Thompson; but the case being insufficient for the reception of the entire number of specimens, another case was made at my suggestion which will be soon filled with specimens.

At first glance, it might appear that the State Cabinet contains too many specimens from the same or adjacent localities ; and to the casual observer, a greater degree of interest in the mineralogy of the State might be awakened, if the specimens were fewer in number and art had been employed to exhibit the beauty of each to its greatest advantage. For instance, the polished specimen of Isle La Motte marble, and the beautiful slabs of Verde Antique marble from Roxbury and Cavendish, elicit the admiration of each spectator, while the rough and unpolished rocks from the same quarries possibly attract no notice whatever.

But the careful student of Natural History and the ardent devotee of geological science desire an exhibition of the material in the rough, and all the forms in which it is found in its natural bed. Such enquirers are not satisfied with a superficial glance at the numerous fossils found in and forming the Isle La Motte marble, and contemplating the changes that have been wrought to render whole races of animated nature extinct and entombed as he sees them, and with a great stride pass from them to an examination of the beautiful statuary marbles of Vermont. He desires to examine the intervening groups to determine if possible, whether there be any connection between the two varieties, and if so, to note the difference and ascertain the producing cause.

It is found that as the limestone approaches the upheaved rocks it becomes saccharoidal or sparry, and apparently destitute of fossils, and eminent geologists are of opinion that our beautiful white marbles are of fossiliferous origin, and altered by the agency of heat and other causes, and that the white unspotted memorial stones in our burying places are themselves the charnel house of myriads of beings that once crawled upon ocean's bed, or sported in the waters of the mighty deep.

In arranging the minerals in the case ordered by Professor Thompson I have endeavored to follow as nearly as possible the plan adopted by your predecessors ; but in the new case I propose with your consent, to vary so far from their plan as to present on a label the full name of the mineral or fossil with that of the locality and donor when known ; by means of which the spectator will be relieved from the disagreeable necessity of consulting a voluminous catalogue to ascertain the required facts and I propose to append the appropriate number to the label and place it in its proper place upon the catalogue.

I would in this connection, remark that the minerals in the State collection as well as those sent to and designed for the different colleges and institutions before mentioned, have been hitherto barely numbered; and in order to ascertain their names, locality &c. reference to a corresponding number in manuscript catalogue was necessary, to supply the desired information. It occurred to me (and your directions clearly point out this desideratum,) that the names and locality should be legibly written or printed and affixed to each specimen, and thus afford the spectator the required information from an inspection of the mineral itself.

Accordingly I have thought it desirable to have printed labels placed upon the minerals with their appropriate number corresponding to the one on the catalogue, and have ordered a suitable quantity of labels to be printed so as to supply the different institutions having a like collection of minerals from the same localities and collected by the same geologist. These labels when in readiness will be transmitted to their final destination upon application of those interested.

It would give me great pleasure if I could arrange the minerals and fossils in groups and in the order in which they occur. For instance, I would be glad to arrange in one case the rocks and fossils belonging to the Champlain division by themselves, so as to indicate the natural order in which the formations occur—beginning with the calciferous sandstone and following in order the birds-eye limestone, Isle La Motte limestone, Trenton limestone, Utica slate and Hudson River shales to the red sandstone formation.

In another case there might be arranged the Taconic group of rocks, giving a separate place to the subdivisions of roofing slate, sparry limestone, magnesian slate, Vermont marbles and granular quartz, and so on, until all the minerals and fossils of the State of Vermont are represented fully, and each in its proper place.

With this arrangement there should be appended to each case a brief description of the group or system therein exhibited, its locality, extent, position and age, compared with other groups represented in adjacent cases.

But in the small room assigned by the Legislature for the exhibition of the specimens already collected, and hereafter to be col-

lected to illustrate the Natural History of the State of Vermont, this arrangement could not be thoroughly carried out. If, however the Legislature should deem it expedient to assign the adjoining room on the east, and order an opening to be made so as to unite the two rooms, there would be ample space to carry out the plan I have suggested, and thus exhibit in a convenient manner the various specimens of scientific and economical interest with which Vermont, more than any other State in the Union abounds.

I would, in this connection, remark that many prominent citizens of our State have shown their willingness and desire to promote the success of this undertaking by making voluntary contributions to the State collection, and others have expressed a determination to do so, now that suitable cases are prepared for the reception and exhibition of specimens.

To such as propose furnishing specimens of marble, slate, steatite, &c., for exhibition in the State collection, I would respectfully suggest that it is desirable, in all cases when practicable, to have the specimens about three inches square, or three inches wide and six to nine inches in length, and not to exceed one inch in thickness ; and with the polished specimens it is desirable to have furnished one or more samples in the rough, as free from hammer marks as possible.

With each specimen there should be given the locality, name of the quarry, the owner's name and that of the donor, that the same may be placed upon a label attached to the specimen.

I have been greatly encouraged while prosecuting my labors at Burlington and Montpelier, to receive evidences from day to day that the public interest in this matter of developing the resources of the State by means of the Geological Survey, has not in the least abated by reason of the unforeseen obstacles and calamities which have surrounded its progress. I have reason also to acknowledge my indebtedness to the learned Professor Hall, of Albany, N. Y., for his labor in determining the genera and species of the various fossils found in the Champlain system of rocks, and I would, before drawing this tedious report to a close, return my thanks to you for the commission with which you have honored me, and I tender my grateful acknowledgements to all from whom

I have received many tokens of kindness during the progress of my geological labors.

With sentiments of high regard,

I remain, Dear Sir,

Your friend and obedient serv't,

ALBERT D. HAGER,

Assistant State Naturalist.

NATURAL HISTORY ROOM, MONTPELIER, VT., {
October 9, 1856. }

APPENDIX I.

Obituary of Professor Thompson.

[The following carefully prepared notice, from the pen of a friend of the deceased, was originally communicated to the "Franklin County Journal," published at St Albans, Vermont.

We discharge a melancholy duty in announcing to our readers the death of this eminent Vermonter. His widely known and universally esteemed reputation justifies us in preparing a detailed memoir of his life and literary labors.

Professor Zadock Thompson, died at Burlington on the 19th of January, 1856, of ossification of the heart. He was born in Bridgewater, Windsor County, Vermont, in the year 1796 and, at the time of his death, must have been in the sixtieth year of his age. His early life was a continual struggle with poverty and his education was acquired while successfully combatting the evils of pecuniary embarrassment. At the advanced age of 27 years he was graduated from the University of Vermont, having for his classmates in 1823 and now living, the Hon. Frederick H. Allen, an eminent lawyer in Boston, and Warren Hoxie, of Westford, Vt.

From his childhood he had a passion for writing and publishing books. His first publications were almanacs, which he sold by traveling about the State on foot to raise means to fit himself for college; and "Thompson's Almanack" became as famous in Vermont as Robert B. Thomas' in Massachusetts. His first bound volume was an Arithmetic, which he published in 1826. This had a general sale through the State, and was superseded in part by others for no other reason than a failure of his publisher to supply the demand during the author's residence in Canada as Principal of an Academy, where he published a Geog-

raphy and map of Canada for schools, which has passed through several editions.

Within a twelvemonth from his graduation he published at Montpelier his "Gazetteer of Vermont" pp. 312 and, in 1833, he published, at Burlington, his "History of Vermont from its early settlement to the close of the year 1832" pp. 252. In the year 1832, he was editor of and principal contributor to the "Green Mountain Repository," a monthly magazine published for about a year in Burlington. After pursuing his study of theology and occasionally teaching at the "Vermont Episcopal Institute" and elsewhere, he was prepared for orders and was ordained to the diaconate in the Protestant Episcopal Church by the Rt. Rev. Bishop Hopkins, in 1836. He subsequently preached in several parishes in Northern Vermont and New York, and supplied the pulpit at St. Paul's Church, Burlington, during the illness or absence of the Rector; but his feeble health prevented his assuming the active and onerous labors of a parish.

From the time, he published his first almanac it was his intention to publish a complete history of the State, and for more than twenty years he was engaged in collecting materials, and for this purpose traveled on foot into most of the towns to have personal interviews with the "oldest inhabitants," examine records, Natural History—Geography, &c., &c. and from 1838 to 1842 he was engaged in preparing from the mass of materials thus collected his general History of Vermont.

At this time, when he had expended all his little earnings in preparing his work, he was so fortunate as to have his friend and neighbor Mr. Chauncey Goodrich voluntarily offer, to furnish all the material necessary, and publish his work, charging only the usual cash prices, for paper and printing, for all which he might pay from sales of the book. This liberal offer enabled him to publish, promptly, an edition of 5000 copies of his work of 656 closely printed, double column, octavo pages, using more than five tons of printing paper, and although the expenditure was more than \$5000 to secure all the profits to himself.

Our Legislature was not unmindful of the great service he had rendered the State. When he issued his proposals for publishing his Civil, Natural and Statistical History of Vermont, they directed the Secretary of State to subscribe for one hundred

copies, and on its publication in 1842, presented him with five hundred dollars. This sum, with the sales of his book, enabled him to pay all his pecuniary obligations, with his large debt to his publisher, in little more than one year from its publication.

Professor Thompson, in all his actions, had a desire to benefit *all*, whether rich or poor in worldly goods. When his publisher, to whom he was indebted for his means for carrying out his plans, and whose opinions were entitled to more consideration than any and all others, for more than six months prior to his issuing proposals for publishing his work, importuned him to publish his History in *three* volumes at \$6, instead of one volume at \$2,50, assuring him that his profits would be more than twice as great, his only reply was, that many would want his book who could pay \$2,50, and could not afford to pay \$6,00; and that it was not right thus to deprive them of a benefit their richer neighbors enjoyed.

The prosecution of this purpose necessarily brought him into contact or correspondence with the naturalists of the country. In completing his account of the birds of Vermont he was greatly assisted by Dr. Thomas M. Brewer, of Boston, in determining several species of Reptiles and Fishes, he was aided by Dr. D. H. Storer also of Boston. For a full description of our molluscous animals, he was indebted to Prof. Charles B. Adams, then of Middlebury College, and to Prof. George W. Benedict, then of the University of Vermont. For his catalogue of plants he was indebted to the late William Oakes, of Ipswich, Mass., to Prof. Joseph Torrey, William F. Macrae, and John Carey, Esquires, and others. With these aids in his arduous labors, Prof. Thompson succeeded in embracing in his work everything of special importance relative to the Natural and Civil History of Vermont; and published it in so condensed and cheap a form as to place it within the reach of every family in the State, having but little regard to a pecuniary recompense from the sale of a book which had cost him so much travel, research, time and expense in its preparation.

Prof. Thompson found time also to prepare annual astronomical calculations for the Messrs. Walton of Montpelier and to publish a valuable arithmetic and elementary work on the Geology and Geography of Vermont for the use of schools, a Geography of Vermont for children, with county maps, and to write for

Silliman's "American Journal of Science and Arts," valuable scientific communications, all prepared in the systematic, lucid and condensed manner which imparted so much value to all of his publications.

In 1845, Governor Slade, appointed Prof. Charles B. Adams State Geologist, who with the approbation of the Governor, appointed the subject of this memoir one of his assistants in the field labor. Prof. Thompson and the Rev. S. R. Hall, the other assistant, visited and explored "more or less thoroughly" about 110 townships in one season; and Professor Thompson was actively engaged in this important scientific labor until the Legislature of Vermont neglected to make an appropriation for a Final Report on the Geology of our State, and thus permitted the materials, manuscripts, books and specimens belonging to the Survey to remain at Montpelier and Burlington locked up in about fifty boxes. The brief and expressive Report of Professor Thompson addressed to Governor Coolidge, in October 1849, was published in the appendix of the House Journal for that year and is a sad commentary on the folly of which our State has been guilty in regard to the matter of a Geological Survey. After the suspension of the Geological Survey, Dr. Horace Eaton, Governor of the State in 1847, appointed Professor Thompson to carry out the Resolution of the Legislature in relation to international literary and scientific exchanges; and in pursuance of his appointment he presented the exchange system in its clearest light so that it commended itself to the approbation of every benevolent mind." The preparation of the Report of "Proceedings and Instructions," which, by the bye, was beautifully printed in a pamphlet of 80 pages, reflected great credit upon Mr. Thompson, and upon the State and it is greatly to be deplored that the historical interest which was then awakened throughout the State by the visit of the founder of the system of exchanges and by the labors of such men as Professor Thompson, Hon. Hiland Hall, of Bennington, Henry Stevens, of Barnet, Daniel P. Thompson, of Montpelier, Prof. James D. Butler, then of Norwich, Vt., and others, should so soon and so thoroughly have subsided and become almost extinct.

In June 1850, Professor Thompson delivered upon invitation an address at Boston before the Boston Society of Natural History in which he made the announcement that "what he had accomplished

in the business of Natural History he had done *without any associates engaged in like pursuits, without having any access to collections of specimens and almost without books.*" In that admirable address (which, as it had only been partially reported and published in certain newspapers, his friend Mr. Goodrich, at his own expense, printed in handsome pamphlet form for distribution,) he illustrated *the importance and difficulties of a thorough cultivation of Natural History, in country places*, insisting that a habit of observation and comparison of objects of Natural History could be as quickly acquired in the country as in the city and urging that the study of Natural History should be more generally taught in our common schools and colleges for the obvious reason that such a study "would refine and improve the moral sensibilities of our people, and sharpen and invigorate their intellectual powers."

In such labors, beset with the difficulties so freely confessed before the "Solid Men of Boston" on the occasion of the delivery of the last mentioned address, he passed his quiet life. At one time he was a teacher of the exact sciences; at another time prosecuting his researches into Natural History; and then he might be found preaching in his modest and reverential manner the sublime doctrines of the Christian creed which he had adopted, and whether in or out of the pulpit always seen and known as the industrious, patient, humble and exemplary disciple of Him who was born in the manger and died on the cross. Professor Thompson thus won friends not "in single spies but in battalions," friends who knowing the anxiety he felt to see the wonders of the great exhibition at London, in 1851, gladly put into his purse that "material aid" of which teaching and preaching, and authorship had not gathered a superabundance. Chiefly through the kindness of friends, which he has beautifully acknowledged in one of his books, he was enabled to enjoy a trip to the Old World, "beholding the wonders of the great deep, and seeing and admiring the wonderful things of Nature and Art which lie beyond it." After an absence of three months, spending a few weeks in London and Paris and after travelling about 7500 miles, he came back refreshed in spirit and health to his humble dwelling at Burlington and after a while yielded to him importunities of his friends and published a neat volume of 143 pages, entitled a "Journal of a trip to London, Paris

and the Great Exhibition in 1851." Although this "Journal" is composed of notes for each day from May till August, jotted down when travelling or sight-seeing, for the private eye of family and friends and with no expectation that they would ever be printed: yet they contain much that is new and valuable, and although published as a "thank offering to his friends," yet the reading public have perused it with equal pleasure and profit.

Since the publication of his History of Vermont in 1842, railroads and magnetic telegraphs have been introduced into the State and other changes have taken place; and early in 1853 Professor Thompson published an appendix to the History, chiefly in the department of the Natural History. This appendix, although, containing only 64 pages, is a most valuable supplement to his large work, and if his life had been spared a few years, as he says in the Preface, he might have re-written the whole history.

We have now arrived in chronological order at his last work, upon which the Professor was engaged when the summons came for him to join the majority and be "gathered to his fathers." It will be remembered that the labors of Professor Adams and his assistant had ceased in 1847 on behalf of the State. The cold shoulder of "men most noted for wisdom and virtue" was turned toward them, after it was an established fact "*that as much labor was performed and as much investigation effected as were ever accomplished with the same expenditure in any other State.*"—Prof. Adams' final report was never made, and January 19th 1853, he died on the island of St. Thomas, W. I., cut down in the prime of life and usefulness, when all that remained of the Geological Survey of Vermont was shut up in short hand in the field-books of the State Geologist, and those of his assistants or locked up in the fifty boxes of unticketed and untrimmed specimens at Burlington and Montpelier. Years after the field work was done and when Prof. Adams was slumbering in his grave, the men "most noted for wisdom and virtue," discovered that they had made a mistake in arresting the progress of the survey. Then it was that Professor Zadock Thompson was appointed by Statute, State Naturalist with the following duties: "to enter upon a thorough prosecution and completion of the Geological Survey of the State, embracing therein full and scientific examination and description of its rocks, soils, metals and minerals; make careful and complete assays and

analyses of the same and prepare the results of his labors for publication under the three following titles, to wit :

First—Physical Geography, Scientific Geology and Mineralogy.

Second—Economical Geology, embracing Botany and Agriculture.

Third—General Zoology of the State.

[Session Laws, 1853 pp. 45, 46.]

He was pursuing the labors of this responsible task which the State had honorably to herself and to him commissioned him to perform, when death bereaved his family and friends and the community of a man who in all things was the type and exemplar of his race. On the same day, three years before, his predecessor went to his long home, both leaving the matter of a Geological Survey, in which both delighted and in which both had spent long nights and laborious days, still unfinished.

At the time of his death, Professor Thompson was a Professor of Natural History in the University of Vermont, an institution to which he had been greatly attached since his graduation in 1823 ; and the eminent self-taught Naturalist who had devoted his life in a quiet and unpretended way to independent scientific enquiry and the labors of authorship and the ministry, died in his humble dwelling near the University with his intellectual armor on ere his "eye had grown dim or his natural force abated." Dr. Thomas M. Brewer, Editor of the Boston Atlas, and a naturalist of great research and acquirement, thus alludes in touching language to the death of his valuable friend.

"His loss both as a citizen and a public man is one of no ordinary character—he has not left his superior in science behind him, in his own State. We have known him long and well, and in speaking of such a loss we know not which most to sympathize with, the family from whom has been taken the upright, devoted and kind-hearted head, or that larger family of science, who have lost an honored and most valuable member. Modest and unassuming, diligent and indefatigable in his scientific pursuits, attentive to all, whether about him or at a distance, and whether friends or strangers, no man will be more missed, not merely in his immediate circle of family and friends, but in that larger sphere of the lovers of natural science, than Zadock Thompson.

"At any time we should hear of the death of such a man with deep regret and grief, and these feelings are increased in the present case, when we remember that he has been called from the field of his usefulness when the great work of his most useful life has been but partly done. But he has been taken, and we may not murmur at the inscrutable decree by which that work has been arrested, just as it was on the eve of completion. New England may have more brilliant and more popular illustrators of her natural science, but one more thorough or more devoted we have never known; nor one who once known has been more honored and esteemed by Naturalists, or beloved by friends, than the late Professor Zadock Thompson."

A correspondent of the "*Gospel Messenger*," a brother clergyman of the Diocese of Vermont, who was present at the funeral together with the Rev. Dr. Hicks, of Rutland, and the Rev. W. T. Webbe, of Middlebury, thus eloquently alludes to the funeral of the deceased which was holden in St. Paul's Church, and to certain characteristics of the lamented Professor :

"A very large congregation assembled at the Church to pay the last tribute of respect to the deceased; and the closing of the stores, shops and offices, in the midst of a very busy day, was a most appropriate and affecting testimony of the estimation in which he was held where his moral worth and scientific character were best known.

"Owing to a disease of the heart which terminated his life, he was long since incapacitated for the pastoral office, and from purchasing that 'good degree' to which the diaconate would have entitled him, and gave himself up to those scientific investigations and employments with whose successful and happy results very many beyond his native State are familiar.

"A very appropriate discourse was delivered at the Church by Dr. Hicks, in which though little was said of the dead, he was briefly and very happily referred to as a man of rare intellectual endowments, who was above all praise in ability and accuracy of scientific research, and who, perhaps, an all-wise Providence directed into such channels, that he might be a witness to their compatibility with divine revelation.

"To his eyes, nature and revelation were pages written by the same Omnipotent finger, and *never disagreeing*; and no man

had a more accurate and discriminating mind, better able to weigh and compare the facts narrated by Moses, or placed upon the more recondite leaves or layers which compose the book of nature, which so many Naturalists and Geologists read with skeptic eyes.

"I could but reflect as I passed by the humble dwelling of his earthly abode on the following morning, under what different circumstances the leap of worlds is made by mortals when the summons comes, and how little influence this world's pomp will have in determining their welcome and distinction in the celestial courts. The rich who live only for ease or enjoyment in the fashions and follies of life, leave sumptuous dwellings and a few dollars, which through prodigal heirs, often perish almost with the pomp of their funeral, while the man we yesterday bore from the unpretending tenement where a lone widow weeps, has bequeathed to the world that which has a value above the wealth of the State to purchase.

"Mr. Thompson has received small aids as Geological Surveyor appointed by the State, and for his services in the College; but not enough to prevent his dying poor—the fate of too many men, who are starved to death by the same public economy which praises them when dead, and erects monuments over their graves!

"But science, sanctified by religion, is a precious jewel, which however despised and neglected in the hands of the poor and unassuming in life, is never lost to the world; and it is of little matter from what unpretending hands or hovels it descends to mankind, and goes up to sparkle in the crown of a Christian student, when this re-constructed tabernacle shall be what talent—not money—makes it."

After these eloquent and deserved tributes, little remains for our partial pen to add. We have known him well since 1834, in his various relations, as a teacher, as a clergyman, as a Professor, as a correspondent, and as a friend. During the quarter of a century that he devoted himself to the instruction of youth, to the labors of authorship, and to scientific research, he exhibited himself as an unselfish and unambitious man. He loved his pupils, his friends, his church, his associates, his State, his town, and, above all, his home. As a teacher, he was kind and tho-

rough ; as a clergyman, what has been appropriately called his "deep and unconquerable modesty of spirit," prevented his ever rising above the Diaconate in the Protestant Episcopal Church. As a fellow clergyman in that able paper, the *New York Church Journal* writes : "the uncertainty of his health for many years past prevented his undertaking the labors of a parish. His gentle, quiet, and deep piety of character won him universal esteem. He was chiefly known by the many works in which he has embodied the history, the topography and the natural endowment of his native State. In natural science, his proficiency was so remarkable that he was in correspondence with most of the leading Naturalists of this country and many of those abroad. He received one of the medals of the late French Exhibition in this department. His place thus made vacant in Vermont, it will be hard to fill."

As an author, he has won high distinction for the profundity of his research, and wonderful accuracy of date and detail has characterized all of his historical productions. His astronomical and meteorological observations were carefully made and noted, and he was one of the best and most reliable correspondents of the Smithsonian Institute.

As his life has been chiefly spent in the development and illustration of the natural productions of his native State ; the scientific world, and especially Vermonters, will cherish his memory as that of a man who devoted his life with energy and singleness of purpose to objects of lasting interest and usefulness to the whole community.

In all of these note-worthy respects, he was not unlike the venerable Professor T. Romeyn Beck, author of the valuable work on Medical Jurisprudence who died in November last at Albany, N. Y., after having been identified for forty years with every leading measure in the State of New York for the promotion of education and medical and general science and letters. Dr. Beck, too, was a teacher of youth, and for more than twenty years of the early part of his life, was the Principal of the Albany Academy. Dr. Beck was, like Prof. Thompson, unambitious and unselfish ; and both occupied comparatively humble positions, but only for the purpose of doing good. Both Professors aimed to render their scientific and literary attainments available,

and both regarded their knowledge as holden in trust for the good of others. The minds of both bore fruit for the world. Both were men of "simple manners, genial nature, social habits, large humanity and radiant faith. The efforts of both to promote education, science, improvement, virtue and Christianity, were always well and wisely directed." Their associations through life were with the truly good and great. The society of both was sought by those who could appreciate public worth and social excellence. In the halls of the Academy and the Capitol; in the recitation room and cabinet of the University which their presence once brightened and gladdened, there are now darkness and sorrow.

Let the memory of such men be kept in perpetual bloom !

SUUM CUIQUE.

ST. ALBANS, VT.

APPENDIX II.

An Act to provide for a Geological Survey of the State.

SECTION

1. Governor directed to appoint a State Geologist.
2. State Geologist may appoint and direct assistants.

SECTION

3. Duties of the State Geologist.
4. Appropriation of two thousand dollars annually for three years.
5. Auditor to allow accounts, &c.

SEC. 1. The Governor is hereby authorized and directed to appoint a State Geologist, who shall have a competent knowledge of scientific and practical geology and mineralogy, and shall be subject to the orders of the Governor for the time being, and removable at his pleasure.

SEC. 2. The State Geologist, with the approbation of the Governor, shall, from time to time, appoint all proper and necessary assistants, fix their compensations, direct them in their labors and remove them and appoint others whenever it shall be found necessary or expedient.

SEC. 3. It shall be the duty of the State Geologist, as soon as practicable, to commence and prosecute a thorough geological and mineralogical survey of the State, embracing therein a full and scientific examination and description of its rocks, soils, metals, and minerals; make careful and complete assays and analyses of the same, and annually, on or before the first day of October, to report to the Governor the progress of the work, the most efficient and economical manner of conducting it, and an estimate of the expense for the ensuing year.

SEC. 4. For the purpose of carrying into effect the provisions

of this act, the sum of two thousand dollars, annually, for the term of three years, is hereby appropriated.

SEC. 5. All claims, under the provisions of this act, shall be presented to the auditor of accounts, for allowance, who shall draw orders on the Treasurer of the State for the amount he shall find due, equal to, but not exceeding in any year, the annual appropriation.

Approved, October 28, 1844.

APPENDIX III.

An Act to provide for completing the Geological Survey of the State.

SECTION

1. The governor to appoint Professor Zadock Thompson, State Naturalist to be subject to his orders and removable at discretion.
2. Duties of State Naturalist.
3. When facts, &c. are collected sufficient to make a volume of five hundred pages octavo, State Naturalist to make report to Secretary of State, with estimate of cost of publication. Secretary of State to issue circulars to the several town clerks, specifying number, &c. of engravings, and also to publishers of newspapers. Town clerks to receive and return subscriptions within forty days.
4. Sec'y of State to issue proposals for printing said work, and that specified

SECTION

- time and place to examine, and accept the lowest responsible bid. Secretary to take a bond from the person whose proposal is accepted, in double the cost of the work. Secretary to distribute the work to the constables of the several towns, who shall collect the cost and pay the same into the state treasury.
5. Volumes under the second and third titles to be published agreeably to sections three and four.
6. One thousand dollars appropriated annually, for three years, and until otherwise ordered.
7. Auditors of accounts to receive and allow all accounts, equal to, but not exceeding the annual appropriation.

It is hereby enacted by the General Assembly of the State of Vermont, as follows :

SEC. 1. The Governor is hereby directed and authorized to appoint Professor Zadock Thompson, State Naturalist ; who shall be subject to the orders of the Governor, for the time being, and removable in his discretion.

SEC. 2. It shall be the duty of the State Naturalist to enter, as soon as practicable, upon a thorough prosecution and completion of the Geological Survey of the State, embracing therein a

full and scientific examination and description of its rocks, soils, metals and minerals; make careful and complete assays and analyses of the same, and prepare the results of his labors for publication under the three following titles, to wit:

First—Physical Geography. Scientific Geology and Mineralogy.

Second—Economical Geology, embracing Botany and Agriculture.

Third—General Zoology of the State.

SEC. 3. Whenever sufficient facts and materials shall have been collected upon the first of the above named subjects to form a volume of not less than five hundred pages octavo, the State Naturalist shall make report thereof to the Secretary of State with an estimate of the size and probable cost of publication, who shall immediately issue a circular addressed to the several town clerks in the state, specifying the nature, size, number of engravings, and estimated cost of the work, and requesting them to post up such circular in their respective offices; also to convey notices of such circular to the public by such other means as they may adopt to receive subscriptions for the work, and within forty days from the time of their receiving such circular, return such subscriptions to the said secretary; and said secretary shall also transmit like circulars to all the publishers of newspapers printed within this State, with a request for gratuitous publication of the same.

SEC. 4. Immediately upon the expiration of the above named period and the return of said subscriptions, the Secretary of State shall issue proposals for printing said work, specifying the size and quantity of engravings, style of binding, quality of paper and number of volumes required, which shall not exceed more than one fifth the whole number of subscriptions returned; the period within which said work shall be completed and the time and place for opening bids; and at the said specified time and place the said secretary shall open and examine the bids, and the lowest bid, having due regard to the ability and responsibility of the persons making the same, shall be accepted. And the said secretary shall take a bond from the person whose bid is accepted, conditioned upon faithful performance of his said contract, in a sum not less than double the cost of the work. And when the said work shall be completed and accepted by said secretary, he shall

cause to be sent to the constable of each town such number of volumes as have been subscribed for in such town, with a list of such subscriptions, and each of said constables shall deliver the said volumes, collect the actual cost thereof, and pay over the same into the treasury of the State.

SEC. 5. Whenever sufficient facts and materials shall have been collected and arranged under the second and third titles specified in section second, the same shall be published in their order agreeably to the provisions of sections three and four of this act.

SEC. 6. The sum of one thousand dollars, annually, is hereby appropriated for the term of three years, and until otherwise ordered by the legislature of this State, for the purpose of carrying into effect the provisions of this act.

SEC. 7. All claims under this act shall be presented to the auditor of accounts for allowance, who shall draw orders on the treasurer of the State for the amount he shall find due, equal to but not exceeding, in any year, the annual appropriation.

Approved, December 6, 1853.

APPENDIX IV.

Report of Zadock Thompson, ON THE GEOLOGICAL SURVEY.

To His Excellency,
CARLOS COOLIDGE, ESQ.,
Governor of Vermont :

SIR:—Having been commissioned by your Excellency to carry into effect a resolution of the General Assembly of Vermont, passed at their session in 1848, in relation to the materials of the Geological Survey of the State, I beg leave to submit the following

REPORT :

In the fall of 1847, Prof. C. B. Adams, the State Geologist, having accepted a Professorship in Amherst College, Massachusetts, and being about to remove his family out of the State, directed me as Assistant Geologist, to obtain a suitable room in Burlington, to serve as a depot for the specimens and materials of the Survey which were to remain in the State. The room being provided about the 1st of Oct. 1847, materials, consisting of boxes of specimens, furniture for the room, tools, &c., to the amount of several tons, were forwarded from Middlebury to Burlington, and deposited in it. The State Geologist removed to Amherst some time in October, and, expecting that provision would be made by the Legislature for the completion of the Survey and the preparation of a Final Report, he took with him the field notes and manuscripts, a portion of the tools and the furniture of the depot, the specimens which had been ticketed for the state collection, and all the specimens containing fossil, or organic remains.

Thinking that the General Assembly, when adopting the resolution for the collection of all the materials of the Survey at Montpelier, might, perhaps, be unaware of the amount of transportation, which would be required, and of the unnecessary expense and inconvenience, which would be incurred by carrying out the resolution literally, I ventured to inform your Excellency of the amount and conditions of the articles at Burlington, and with your consent have suffered them to remain unmoved.

Professor Adams, who had in his possession the materials of the Survey, which had been carried to Amherst, left that place before I received my appointment, and passed the winter at Jamaica in the West Indies. He returned to Amherst in May, and in the latter part of that month, I went to that place and procured from him the field notes and tools, and the specimens which had been ticketed for the State collection. The specimens containing fossils, were unticketed, and Prof. Adams was entitled to a share of these in virtue of an arrangement between him and Gov. Slade, when he received the appointment of State Geologist. He also had a claim for the rent of the room at Amherst, in which the materials were kept. Being in doubt whether I was authorized by the resolution to make the division of the specimens, and to pay rent, I returned to obtain the advice and direction of your Excellency. After receiving it I again proceeded to Amherst, divided the fossils with Prof. Adams, paid the rent of the room with articles of furniture, which would cost in the State but little more than their freight from Amherst to Montpelier, and forwarded the fossils, belonging to the State and the remaining articles of furniture, to Montpelier.

The materials of the Survey delivered into the charge of the State Librarian, consist of one roll of maps, one box, containing manuscripts and tools, 11 boxes of specimens ticketed for the State Collections, 11 boxes of specimens containing fossils, which are unticketed, 16 trays for minerals, and two small stands.

The materials in the room at Burlington, consist of a variety of tools and furniture, and about 50 boxes of specimens which are untrimmed and unticketed, being in the crude state in which they were collected in the field. The gross weight of these 50 boxes amounts to several tons.

The first 11 boxes of specimens mentioned as being in charge of the State Librarian, embrace all the specimens which are now in

a condition to be placed in the State Cabinet. Those in the other 11 boxes at Montpelier, and all the specimens at Burlington, require to be examined, trimmed, ticketed and catalogued, to make them valuable in the State collection or in any other.

The room in Burlington, in which the materials of the Survey are deposited, was hired by direction of the State Geologist at an annual rent of \$20. This rent since Oct. 1847, has not been paid. I am informed that all the money appropriated has been expended. I also find an unpaid bill of \$1,62 for transportation, which has not been embraced in the accounts paid by the Auditor. These amounting to \$42,62, I believe to embrace all the indebtedness of the Survey.

With the highest respect, I am

Your Excellency's ob't serv't,

Z. THOMPSON.

Montpelier, Oct. 11, 1849.

APPENDIX V.

Mr. Eaton's Report.

IN SENATE, OCT. 31, 1837.

Mr. Eaton, from the Committee on Education, to whom was referred the communication of His Excellency, the Governor, with accompanying documents, on the subject of a Geological and Topographical Survey of the State, submitted a Report, from which the following is an extract :

"In a *Geological* Survey the various rock formations which support the soil must be ascertained, and their characters and their relations must be compared with those of similar rocks in other parts of the world. The peculiarities of known mineral veins—the regions where valuable mineral treasures, such as metallic ores, coal beds, marl bottoms, useful substances for architectural and other purposes, may exist, and of course be wisely sought for, must be pointed out, and also the regions where, judging from the experience of the world, it will be in vain to look for them. The nature of the various coverings which overlie the solid foundations of the State must also be investigated, and their relations to the natural and artificial vegetation found on them. The connection of these facts with such natural causes as are known to have operated in the world, or are now in action, needs also to be traced as far as practicable."

The importance, then, of these Surveys would perhaps be sufficiently obvious to every intelligent mind. The Legislatures of some of the neighboring states have so far appreciated their value and importance as to order them—more especially *Geological* Surveys—made at the public expense; and in other in-

stances, individuals, prompted by the love of science, and a desire to extend the blessings it confers upon mankind, have pursued their labors and enquiries to a very considerable extent. And wherever these surveys have been made, they have been attended with useful results to the various branches of industry and enterprize.

But although the Committee have thus classed these surveys together, and acknowledged the importance of both; still their execution is not necessarily connected, and there is, in the estimation of your Committee, a considerable difference between them in point of immediate practical utility. It is true a Topographical Survey, by fixing certain station points in various parts of the State and determining their relative height, with their distances and direction from each other—and by ascertaining the drainage or fall of streams from their sources to their mouths, would form data for calculation relative to the construction of canals and railroads. It would enable us, likewise, in any given place to determine the position or direction of the true meridian; to settle the boundaries of towns and counties with such unvarying precision as almost to supersede the necessity of the usual landmarks; to ascertain with unerring certainty from time to time the variations of the magnetic needle—without having recourse to the more tedious process of astronomical calculations, now so often necessary to determine these points. These, it must be admitted in general terms, are objects of high importance. But the data which would be indispensable in calculations relative to the construction of canals and railroads, would be of little practical use until business and wealth should indicate the necessity and furnish the means of putting these works in operation; and the other advantages which have been alluded to, can be dispensed with, although at the expense of some *inconvenience*, and perhaps at times *uncertainty*, in important calculations.

That some preliminary facts, relative to the Topography of the State, would form a starting point for geological investigation, and in a considerable degree facilitate its progress, is readily admitted; and if it were a settled point that both Surveys should be undertaken within a few years, unquestionably the Topographical should take precedence in order of time. But as one is not essential to the accomplishment of the other, and as the expense of

an accurate Topographical Survey, carried only to such an extent as would doubtless be deemed advisable, if it were undertaken at all, would be, according to the estimates before us, not less than ten or twelve thousand dollars, the Committee, in view of the considerations already suggested, and others yet to be adverted to, are of the opinion that a Geological Survey should be *first* undertaken, leaving the other enterprize to some future period, when its execution should be more imperiously demanded by the wants, and more clearly justified by the wealth of the State. If this order of proceeding were adopted, the relative localities of various formations could not, it is true, be so precisely determined; but still the positive location of each could be marked by indicating its position relative to other fixed objects; and the names of towns would have to be substituted, in a description, for those of some more definite points, whose precise relations could be universally known.

It might be thought by some lovers of science, who look at the remote as well as at the immediate advantages which science always brings, that the Committee have taken a narrow and limited view of the subject, and that they should have recommended the immediate execution of a Topographical Survey, in terms of the warmest commendation. But representatives, as they are, of a peculiarly practical and real-life people, they would not, whatever might be their own private opinions, feel justified in recommending to them any expensive enterprize from which they could not expect to derive some *direct*, as well as *definite* and *tangible* advantage.

But it does not require any broad and comprehensive view of the subject in order to discover the immediate and direct benefits to be derived from a Geological Survey of the State. These benefits are too clear and obvious not to be discernible at the most hasty glance. If they were limited to a development of our mineral products, in the shape of metallic ores, (as some might be disposed to limit them, if they had made no inquiry to ascertain the proper boundaries of geological research, and the appropriate objects which come within its scope,) even this would not be deemed a matter of small importance. Accident, without the aid of any thing like scientific and systematic investigation, has already brought to light many valuable treasures in the shape of iron,

copperas, manganese, marble, &c., whose importance as sources of wealth to our State, none can fail to appreciate. What other additional discoveries might be made by a thorough Geological Survey, its accomplishment alone could determine. Another obvious and palpable benefit to be derived from such a survey, would be the prevention of those fruitless searches so often engaged in at the expense of much time and labor, for discovering articles, which the science of Geology might assure us are not to be found within our limits. We might, as one of these visionary schemes, name the project of boring for salt water, entered into a few years since in this State. Geology, on the authority of well known laws, would have informed us beforehand that the search would end in disappointment—that we might as well expect to find the white bear of the polar regions herding with lion in an African desert, as to find salt springs in such a locality, or amidst such geological formations as this part of the country exhibits.

But when we enter further into the broad field of inquiry, which the science of Geology legitimately opens before us, we find other ends to be accomplished and other advantages to be acquired, besides the mere discovery of what are usually termed mineral treasures. Among the most prominent and important of these advantages would be the development of facts having a direct bearing upon the advancement of agricultural science. The various kinds of soil which the surface of the globe exhibits, consist of decomposed rocks, and are as easily reducible to a regular and exact classification as are any of the various mineral productions which lie scattered over the surface of the earth, or imbedded in its bosom. Geology gives to each of these various kinds and varieties of soil, its specific name. Each of these varieties of soil, too, is more especially favorable to the growth of some certain vegetable products. There is scarcely a tree, a plant, or a flower that does not manifest a fondness for some certain locality, and exhibit an attachment to some particular soil as most congenial to its nature. And it comes within the legitimate province of Geology to note these facts. There is then, most clearly, an intimate relationship between this science and that of agriculture, and in truth the former might be said to constitute the basis of the latter. And your Committee believe that the proposed

survey would give to the agricultural interest in this State a new impulse, and inspire it with new life; especially if those entrusted with the execution of the enterprise, were instructed to keep this object steadily in view. There are in every town in this State intelligent men, whose knowledge of these sciences and their relations is indeed limited, but who are capable of appreciating their importance, and would acquire, in the progress of the work contemplated, a vast amount of practical information, which would gradually be diffused through every town and neighborhood in the State. Among other beneficial results of this information, one would doubtless be the prevention of those errors so often practised, of committing plants to inappropriate and uncongenial soils—errors which are as certain to insure a failure, as would be the planting of the hyacinth upon the brow of the volcano.

Admitting then the *utility* of the measure proposed, the next question which would properly present itself for consideration would be its *expense*. From the estimate made by Prof. Benedict, apparently with much care, it might safely be set down as not exceeding twelve thousand dollars, including the expense of publishing the necessary report. This would amount to less than five cents for each individual in the State, and the payment of this sum might, as suggested by Prof. Benedict, be extended into two, three, or more years, according as it should be deemed expedient to prosecute the work with greater or less rapidity. And in view of the immense benefit to be derived, your Committee has no hesitancy in expressing the opinion that the work should be immediately undertaken.

But inasmuch as the subject has been never fully before the people of the State, and the measure proposed involves considerable expense, they forbear recommending any appropriation for this object the present session—choosing to leave the decision of the question to the intelligence of the people—confident in the belief that they will appreciate the importance of the subject, and that the popular voice will demand the commencement of the enterprise another year.

APPENDIX VI.

Extract from Prof. Thompson's Address, on the Natural History of Vermont.

The Green Mountains have, for some years past, presented to geologists an interesting problem, which was—the determination of their geological age and character, and particularly the age and character of that portion of the western slope of these mountains which have been denominated the *Taconic System*. And as the larger part of this range of mountains was within the limits of Vermont, the attention of the geologists of the country was directed to the geological survey of that State, as being likely to furnish a satisfactory solution of the problem; and during the continuance of the survey, that object was kept constantly in view by those engaged in it. Many sections were traced from the well known Silurian rocks, which occupy the valley of Lake Champlain, to the center of the Green Mountain range, and many facts were brought to light which have an important bearing upon the problem which I have mentioned; but just as the examinations were being completed, and the results and facts were to be brought together, systematized and weighed, the survey was suspended; and whether it will ever be resumed or not, is a problem which time only can solve.

The rocks in the western part of Vermont, in the valley of Lake Champlain, are highly fossiliferous and clearly belong to that portion of the lower Silurian, denominated by the New York geologists, the Champlain group. To the eastward of these, and mostly in the south part of the State, lie the so-called Taconic

rocks. These last consist principally of slates, limestone,* and quartz rock. A few fossils are believed to have been found in them, but they are extremely rare and obscure ; and the question with regard to these rocks is, as I understand it, whether they are a series of fossiliferous rocks which are older than the Champlain group, or are metamorphic members of that group, whose fossils have been mostly obliterated by heat.

To the eastward of the Champlain and Taconic group, I am not aware that any fossiliferous rocks have been found, in place, within the State. Lying next to these, is a belt of talcose slate formation, varying from 15 to 30 miles in width, and extending through the entire length of the State from south to north. This belt embraces all the highest summits of the Green Mountain range. The rocks, though generally more or less talcose, contain in many places, a large proportion of mica, and in some places are highly chloritic. Near the eastern margin of this belt there is a narrow range of steatite, extending through the State, having associated with it or embraced within it, in many places, extensive beds of serpentine rock, which are capable of furnishing, in great abundance and of excellent quality, that beautiful variety of magnesian marble, called *Verd Antique*. In this serpentine, in the north part of the State, large veins of the magnetic oxyde, and also of the chromic iron, have been opened. The whole belt which I have mentioned, is entirely destitute, certainly in the north half of the State, both of limestone and granite.

Between this belt of talcose rocks and Connecticut river, the formation consists of clay, mica, hornblende, and talcose slates, gneiss and limestone frequently interstratified, and of numerous protrusions, and some extensive regions of granite. This granite is of excellent quality for building-stone, but the limestone of this formation is all too silicious for the manufacture of good quicklime.†

*The limestone of this series furnishes inexhaustible quarries of the most beautiful white marble.

†While all the western parts of Vermont abound in the best of limestone, there is in the eastern and north-eastern parts of the State no limestone from which good quicklime can be made. In the south-western part of Windsor county, and western part of Windham county, there is a gray limestone, and in the north-eastern part of the State are extensive beds of shell marl, which make a tolerable lime for ordinary purposes. The marl-beds were originally formed in the bottoms of ponds ; but these ponds have, in

One of the most marked peculiarities in the geology of Vermont, is found in the general dip of the stratified rocks, which is, with a few trifling exceptions, towards a synclinal axis extending north and south near the center of the Green Mountain range. Along the shore of Lake Champlain the rocks are nearly horizontal, having only a slight easterly dip; but the dip increases pretty uniformly, in proceeding eastward, till it becomes vertical at a line a little westward of the principal summits of the Green Mountains. From this line, for a distance of seven or eight miles eastward, the dip of the strata continues nearly vertical. This space embraces the highest part of the mountain range, and, to the eastward of it, the general dip of the rocks is distinctly westward; but the rocks are here more disturbed, and the dip less uniform, than on the west side of the mountains.

With regard to the question, whether the rocks, which form the Green Mountains and extend eastward to Connecticut river, are truly primary, or antepalæozoic, as was formerly supposed, or are metamorphic silurian rocks, which are newer than the Champlain group, as has been more recently suspected, I would only observe that evidence in favor of the latter opinion was constantly accumulating during the continuance of our survey, and has been greatly increased by the labors of Mr. Logan, the provincial geologist of Canada, along our northern boundary.

The rocks in place, in Vermont, are, for the most part, covered by the drift formation; but wherever exposed, they are found to be worn and smoothed, and, usually, striated or scored in the direction in which the drift materials have been transported, which is, generally, from a little west of north to a little east of south; but this direction is, in various places, very considerably modified by the direction of the ridges and valleys being north and south in the lower parts of the valleys of Lake Champlain and of Connecticut river, but from north-west to south-east, and in some places nearly from west to east, in the valleys and gorges of the Green Moun-

many cases, entirely disappeared, and the places they occupied become dry land. One of the most interesting of these marl-beds is in Williamstown. It covers about seven acres, and is in some parts 18 feet deep. It is a very pure carbonate of lime, consisting entirely of comminuted fresh water shells. This marl is formed into a paste, moulded in the form of bricks, and then burned in a kiln. The quicklime thus obtained is quite white, and for most purposes is scarcely inferior to that obtained from the Champlain and Taconic limestone.

tains. Vermont furnishes many very interesting cases of the transportation of boulders to a distance of many miles from the quarries in which they originated. Rolled masses of a peculiar kind of granite, often of several tons weight, are found scattered over the lower parts of Caledonia county, from 20. to 30 miles to the south-eastward of the locality, in Orleans county, from which they were evidently derived, and blocks of a calcareous sandstone, found, in place, only along the shore of Lake Champlain, are met with far into the interior of the State, and, in some cases, to the eastward of the principal summits of the Green Mountains.* I mention these merely as examples. Many other cases might be adduced of equal interest.

The unstratified drift in the western part of the State, and the Champlain rocks, are to a great extent covered by a post-tertiary marine deposit of stratified sand and clay, which has been called the *Pleistocene* formation. The strata of this formation are nearly horizontal, and are, for the most part, undisturbed and regular, showing that they were deposited in a tranquil sea. The depth of this deposit, in places, exceeds 100 feet, and the highest parts of it are about 400 feet above the present level of the ocean. The fossils found in it are considerably numerous, and are, in general, such as are now found in a living state on the coast of New England. The fossil bones of a small species of whale, which I had the pleasure to exhibit before this Society in December last, were found in this formation.

From the remarks which I have made, it must be obvious that Vermont combines in its geology the characteristics of western New England with those of New York. The meeting, in Vermont, of two great botanical and zoological districts or provinces, is equally apparent.

* Some of these boulders are found resting at a level 50 feet or more above the highest parts of the same rock as they are now found in place.

APPENDIX VII.

Extract from Prof. Thompson's Address on the Natural History of Vermont.

Vermont, for a small inland State, is regarded as peculiarly rich in vegetable productions ; and some portions of the State have been pretty thoroughly explored by skillful botanists. When its settlement was commenced, its entire surface was covered with forests, which were probably unsurpassed, in density and luxuriance, by those of any other section of our country of equal area. The sugar maple and white pine found no where else a more congenial soil ; and the evergreens, spruce, and fir, which covered the surface of our mountains, and first suggested for them the name of *Verd Mont*, grow to a respectable size almost to their highest summits, several of which exceed 4,000 feet in height. With the exception of seven or eight species, our list of forest trees embraces all that have hitherto been found in New England, and three, or more species, which have been found in no other New England State.

Aside from the marine plants furnished by the sea board, and a few alpine plants found on the White Mountains of New Hampshire, Vermont is known to produce nearly all of the indigenous plants of New England, and in addition to these, some 40 or more species, which are not found in any other New England State. These forty or more species, which are not found to the eastward of Vermont, are mostly confined to the western border of the State and are, in general, such as are common in the State of New York, and further westward. As the botany of Vermont has yet been only partially explored, there still being considerable sections of the State which no skillful botanist has ever visited, it is not unreasonable to suppose that many *new plants* remain to stimulate and reward the labor of future search.

While the laborers in Vermont, in the fields of Geology and

Botany, have been very few, those engaged in the investigation of the Zoology of the State have been still fewer. The meagre account of our animals contained in Dr. Williams' valuable history of Vermont, until very recently embraced almost all that had ever been published respecting them. But that work was written at a very early period, when the subject of Natural History, in this country, was little understood, and when an examination of the State, to which it relates, had hardly been commenced. In that work, (although the attempt to assign to our animals and vegetables their scientific names, was a failure,) he collected together from the hunters and early settlers, much that is valuable in relation to the magnitude, habits, &c., of our larger animals, and saved from oblivion many facts which are no where else preserved.

After the publication of Dr. Williams' history, the last edition of which was issued more than forty years ago, nothing further was published respecting the Natural History of the State, excepting a catalogue of Vermont minerals by Prof. Frederick Hall, and a catalogue of the plants of Middlebury and vicinity, by Dr. Edwin James, previous to the publication of my Natural and Civil History of the State, in 1842. Having myself, devoted considerable attention to the *vertebrata* of the State, and being kindly aided in the department of botany by the late William Oakes, Esq., of Ipswich, Mass., and in conchology by Prof. C. B. Adams, then of Middlebury College, with occasional assistance in other branches of zoology, kindly rendered by members of this Society, I was enabled to embrace in that work nearly all that was then known of the Natural History of the State. Since the issue of that work, much more has been done, and many facts accumulated, which have not been made public, and still the investigation of some branches of the Natural History of Vermont is not yet commenced.

Quadrupeds and birds possess such facilities for locomotion, that they could not be expected in Vermont to differ much from those of the neighboring States. The number of species of our native quadrupeds, which have been carefully determined, is, at least, 45; and of birds more than 160 species have been ascertained.

Our largest native quadruped, the Moose, which grew to the size of an Ox, and whose flesh furnished to our early settlers an

excellent substitute for beef, is now, if not entirely exterminated, confined to a small section in the north-east corner of the State. The Beaver, whose skin was once an important article of export, is wholly extirpated. The Panther, the Wolf, the Wolverine, the Deer, the Bear—in short all the larger species, have been gradually diminishing, and most of the kinds have become exceedingly rare. The native black Rat (*Mus Americanus*) has vanished but the *immigrant* gray Rat, (*Mus decumanus*) has in some parts of the State, usurped its place, and has become a great nuisance. Yet it is a curious fact that there is, in the north part of the State, an extensive region which has been settled more than half a century, in which, it said, no rats were ever seen.

In the birds of Vermont, considerable changes have taken place since the settlement of the country, in the number of individuals of the same species at different periods; and there have probably been also a withdrawal of some species and the substitution of others. Of some species, which abounded when the country was new, an individual is now seldom, or ever seen; while other species, which were then unknown, have been exceedingly common. The American Crossbill, (*Loxia curvirostris*) and red-headed Woodpecker, (*Picus erythrocephalus*), may be mentioned as examples of the former, and the Cliff Swallow, (*Hirundo fulva*), of the latter. Forty years ago, as I well remember, the red-headed Woodpecker was one of the most common birds in our forests; but is now so rare that, while I have traveled extensively over the State, I have hardly seen half a dozen in the last 20 years. On the other hand, I cannot learn that a Cliff Swallow was ever seen in Vermont till about the year 1817; but they now swarm in hundreds, about the eaves of barns in various parts of the State.

While the species of the two higher classes of the vertebrata of Vermont are, generally, the same as in the other New England States, the case is quite different in regard to the reptiles and fishes; so much so, that in reference to these, the Western part of Vermont clearly belongs to a different Zoological district from the eastern, and from the other parts of New England. The dividing line between these districts is along the summits of the Green Mountain range, which separate the waters falling into Connecticut river from those which are tributary to the St. Lawrence. The reptiles and fishes found in Vermont to the eastward of this

line, are such as are common in other parts of New England, while those found to the westward of it, are generally different, corresponding, for the most part, with the fauna of Western New York. Of the reptiles found in the western part of Vermont, which are not, so far as I am informed, found to the eastward of the Green Mountains, may be mentioned the *Emys geographica*, the *Trionyx ferox*, the *Rana horiconenses* and the *Menobranchius maculatus*. Our Ribbon Snake, if identical, as it probably is, with the Coluber Sauriter of the eastern part of New England, often far exceeds in length the measurement of this species usually given in books.

But the fishes on the two sides of this dividing line differ even more than the reptiles. The whole number of species of Vermont fishes is about fifty. Of these more than forty species are pretty well determined; and of those determined, not more than four or five are common to the two sides of the Green Mountains. There are perhaps seven or eight species, which are found on the east side of the mountains and not on the west, and at least thirty species on the west side, which are not found in any Vermont waters on the east side; and more than twenty of these thirty species are not, so far as I am informed, found in any other New England waters. Of these twenty or more species not found to the southeastward of western Vermont, *six* belonging to the Perch family, *four* to the Salmon family, *three* to the Herring family, *two* to the Pike family, *two* or more to the Carp family, *one* Cottus, *one* Corvina, *one* Catfish, *one* Eel, and *one* Sturgeon.

The Mollusca of Vermont have, by the labors of Prof. G. W. Benedict and Prof. C. B. Adams, been pretty thoroughly examined; but hardly any attention has been given to the other classes of our invertebrated animals. There are I believe, a few species of fresh water Mollusks, in Lake Champlain, which have been found nowhere else, and a considerable number of species which are not found to the eastward of the Green Mountains. One of these last, is the *Limnæa nugasoma*; and the only known locality of this species in Vermont is in Burlington, where they have sometimes been found plentifully in a few small creeks in low stages of the water, but from which it is feared they will soon be exterminated by the drying up of the creeks, in consequence of their having become exposed to the sun and winds by the removal of the forest trees and shrubbery which protected them.

APPENDIX VIII.

Resolution to set apart a room in the State House for the State Naturalist.

OCTOBER 18, 1855.

Resolved by the Senate and House of Representatives, That the Sergeant-at-Arms be and is hereby directed to set apart and prepare the committee room, numbered fourteen, for the use of the State Naturalist, for the deposit and arrangement of the specimens collected and to be collected in the Geological, Botanical and Zoological Survey of the State.

APPENDIX IX,

Contents of the proposed Volumes,

BY ZADOCK THOMPSON.

NATURAL HISTORY OF VERMONT.

VOL. I.—GEOLOGY OF VERMONT.

PART I—SCENOGRAPHIC GEOLOGY.

Aspect of the Country.
Mountains.
Hills.
Water Sheds.
Vallies.
Chasms.
Caves.
Springs.
Streams.
Ponds.
Lakes.
Swamps.

PART II—SCIENTIFIC GEOLOGY.

General View of the Vermont Rocks.
Age of Vermont Rocks.
Order of Succession.

Description of the Champlain group, and characteristic fossils.

Description of the Potsdam Sandstone.

"	"	Calciferous Sandstone.
"	"	Isle La Motte Limestone.
"	"	Trenton Limestone.
"	"	Black Shales.
"	"	Dove-Colored Limestone.
"	"	Red Sand-Rock Series,

Taconic Rocks :

Sparry Limestone,
Taconic Slates,
Magnesian Slates,
Stockbridge Limestone,
Granular Quartz.

Brown Iron Ore Series :

Silicious Limestone,
Quartz,
Kaolin,
Lignite.

Green Mountain Rocks :

Talcose Slate,
Clay Slate,
Chlorite Slate,
Green Mountain Gneiss,
Mica Slate,
Steatite,
Serpentine.

Calcareo-Mica Slate Formation :

Clay Slate,
Silicious Limestone,
Mica Slate,
Hornblende Slate,
Silicious Slate,
Gneiss.

Igneous Rocks :

Granite,
Trap,
Porphyry,
Feldspar,
Quartz.

Superincumbent Formations :

Drift Formation and Phenomena,
 Erratic Blocks, Boulders,
 Gravel, Sand,
 Moraines,
 Pleistocene Formation,
 Brown and Blue Clays,
 Fossils of the Pleistocene.
 Mammals, Elephos, Belaga, Equus.
 Shells, Mya, &c.
 Woods.

Modern Formations :

Marl and Muck Beds,
 Alluvion.

PART III—MINERALOGY.

General Notice of Vermont Minerals.
 Catalogue of Minerals.
 Description of Minerals and Localities.

PART IV—ECONOMICAL GEOLOGY.

Building Materials:

Granite,
 Gneiss,
 Limestone,
 Marble,
 Quick-Lime, Water-Lime.
 Serpentine,
 Steatite,
 Slate,
 Clay, Roofing, Writing, Pencils, Flagging and Tiling.
 Mica, &c., Flagging.
 Clay and Sand,
 For Bricks, Fire Bricks, Pottery.
 Kaolin, for Pottery, Paper, &c.,
 Sand, for Glass, Moulding,
 Earths, Ochres, Paint, &c.

Metallic ores and Mining :

Iron,
Manganese,
Copper,
Lead,
Silver,
Gold,
Zinc,
Cadmium.

NATURAL HISTORY OF VERMONT.

VOLUME II.—BOTANY.

Preliminary Remarks.

PART I.—CLIMATOLOGY AND METEOROLOGY.

Temperature, Elevation—Comparison :

Rain,

Snow,

Hail,

Fog,

Range and Changes of Temperature,

Phenomena of Lake Champlain,

Anchor Ice,

Meteors, Rainbow,

Aurora Borealis,

Thunder and Lightning.

PART II.—SCIENTIFIC BOTANY.

Catalogue of Indigenous and Naturalized Plants.

Woods of Vermont, Shade Trees,

Shrubs of Vermont,

 Berries, Ornamental Shrubs,

 Shrubs useful.

Herbaceous Plants.

PART III.—AGRICULTURE.

Varieties of Soil,

Analysis of Soils.

Mineral Manures :

Muck,
 Marl,
 Clay,
 Sand,
 Gypsum.

Artificial and Organic Manures :

Dung,
 Ashes.

Field Crops :

Grasses,
 Wheat,
 Rye,
 Oats, Peas,
 Barley,
 Maize,
 Potatoes, Pumpkins,
 Turnips, Beans,
 Carrots,
 Beets.

Garden Crops :

Cabbages, Cauliflowers,
 Onions,
 Parsnips,
 Tomatoes, Beans,
 Horse Radish,
 Rhubarb,
 Celery,
 Lettuce,
 Radish.

Tree Fruits :

Apple,
 Pear,
 Plum,
 Cherry,
 Peach,
 Quince.

Shrub Berries :

Currants,
 Gooseberries,
 Raspberries,
 Barberries.

Vinous and Herbaceous Fruits :

Grapes,
 Strawberries.

NATURAL HISTORY OF VERMONT.

VOLUME III.—ZOOLOGY.

Preliminary Chapter.

Vertebrated Animals :

PART I—MAMMALIA—QUADRUPEDS.

Catalogue of Vermont Quadrupeds,
 Native—Introduced.

PART II—ORNITHOLOGY—BIRDS.

Introductory Remarks,
 Catalogue of Vermont Birds,
 Wild—Domesticated.

PART III—HERPETOLOGY—REPTILES.

Introductory Remarks,
 Catalogue of Vermont Reptiles.

PART IV—ICHTHYOLOGY—FISHES.

Introductory Remarks,
Catalogue of Vermont Fishes.

Invertebrated Animals.

PART V—ARTICULATA—ARTICULATED ANIMALS.

Insects,
Remarks,
Catalogue of Vermont Insects,
Descriptions of Insects, Injurious,
Myriapeds,
Spiders, Arachnoidians.
Crustaceans,
Annelidians.

PART VI—MOLLUSCA, SHELLS.

 PART VII—RADIATA.

APPENDIX X.

The true Value of Chemical Analysis of Soils.

BY DR. JOHN D. EASTER, OF BALTIMORE.

[From the Journal of the N. S. Agricultural Society, 1856.]

It is not long since the practical farmer sneeringly derided the value of book learning and stubbornly resisted the interference of scientific men, in what he considered a purely practical business. But that feeling seems to have passed away, and even those who still refuse to acknowledge the value of scientific researches upon the composition of the soil, and its relation to the functions of vegetation, are not slow to avail themselves of the benefits which others have derived from them. Indeed we have reason to fear that scientific superstition has taken the place of scientific incredulity, and the farmer now expects as much too much from chemistry, as he formerly expected too little. The result of these overwrought expectations is, naturally, disappointment, and the deluded farmer throws the blame of his failure on science, and is more than ever determined to adhere to his old ways.

I propose, in this paper, to consider the true use of chemical analysis of soils, and some of the requisites of a valuable analysis.

As it is from the soil that plants derive the principal part of their constituent elements the presence in the soil of these elements, in forms in which they may be absorbed by the rootlets of the plants and assimilated in their cells, is indispensable to their

perfect growth. Where the want of fertility arises from the absence of one or more of these constituents, or their being locked up in combinations in which plants cannot use them, chemical analysis is perfectly competent to detect the cause of the evil and point out its remedy.

But the growth of plants is influenced by a multitude of other circumstances to which chemical analysis can furnish no clue. A soil may abound in all the elements of a very fertile one, and yet be perfectly barren. The soil of the great Colorado desert in California, which I have recently analysed, furnishes a good example of this. It possesses in abundance every element necessary to extreme fertility, but is entirely barren from the want of water.

The reverse of this also frequently occurs. The chemist receives a specimen of soil, in the chemical constitution of which he can detect no deficiency, and in his laboratory, he can assign no cause for its alleged unproductiveness. An examination of the locality probably shows him that it is underlaid by a stiff tenacious subsoil, which retains an excess of water, and no provision has been made for drainage.

The difference in the mechanical texture of stiff and loose soils is familiar to every one. The fertility of many stiff clays may be seriously impaired by ploughing too wet, rendering them tough and impenetrable to the tender rootlets of plants. In this case, as no chemical change takes place, the chemist in his laboratory would seek in vain for the cause of the difficulty.

Every attempt to improve the character of a soil must therefore be preceded by a judicious consideration of its mechanical texture, its power of absorbing and retaining water, and its capacity for heat. Hence it is important that the agricultural chemist should, if possible, himself examine the locality, in order fully to estimate the wants of the soil. The employment by every State, of an agricultural chemist, who should visit in person every part of the State, is therefore strongly to be recommended.

In the next place it is requisite that an analysis of the soil, in order to be of much value, should be thorough. It must include separate estimations of the parts soluble in water and in acids, and the insoluble portion. For the portion soluble in water represents what is available for the wants of the growing crop,

while the portion soluble in dilute acids is the index of what may by decomposition become the food of plants. This undecomposed portion of the soil may often, by the application of lime, ashes, and other caustic manures, be more speedily decomposed and rendered available.

The analysis should include also, if possible, the sub-soil, as well as the surface soil, in order to guide the farmer in the process of deepening his soil. There are, of late, many advocates of indiscriminate deep-plowing. But a fertile soil may be underlaid by a barren sub-soil, by throwing up large quantities of which the fertility of a field may be destroyed for years. The sub-soil, not unfrequently, contains large quantities of protoxide of iron and other substances which are injurious to vegetation until they have been subjected to the action of the atmosphere. On the other hand, the sub-soil often contains elements of fertility which are not so abundant in the surface soil, in which case, deep plowing will improve both. It is important that the agriculturist should know these differences in order that he may know where he should plough deep, and where refrain.

A still more important consideration is, that no analysis can be of any value to the farmer who is not himself a chemist, unless it be accompanied by a discussion of the indications it affords, and a recommendation of suitable means of improvement. Our agricultural journals and reports abound in analyses which are about as intelligible to the unscientific farmer as the inscriptions on the pyramids, or a chapter from La Place's *Mechanique Celeste*. Most of our intelligent farmers know that lime, phosphoric acid, and the alkalis, play important parts in the economy of vegetation, but few of them have any idea how much of each of these valuable ingredients is requisite to fertility, or what are the best means of supplying their deficiency. Until every farmer is also a chemist, an analysis of a soil or manure which is not followed by a commentary on its defects or virtues, leaves him just where the diagnosis of a disease, without a prescripton for its relief, leaves the patient. He is no wiser nor better off than before. It will not do to presume that when the chemist pronounces what a soil contains, the argiculturist will know what it *ought* to contain, and